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TYPES OF AMMONIA COMPRESSORS

Principles of Action, Methods of Arrangement, Advantages Claimed, and Some Details of Construction

IN THE COMPRESSION SYSTEM of refrigeration, the ammonia compressor is one of the vital elements and it is important to understand the different types, why certain arrangements are used and how they compare in construction and details of operation. In taking up the subject, compressors may be classified, first, according to the position of the cylinders, into vertical and horizontal types; second, according to the design of the cylinder, into the single and double acting; third, according to certain details, into various divisions such as clearance and non-clearance, jacketed and non-jacketed, wet and dry compression; these divisions are of less importance than the others mentioned and may of course be combined with or crossed with any of the other classifications.

So far as the compressor end is concerned, it makes no difference whether the motive power is an electric, a belt drive or a steam engine cylinder, hence, the method of driving the compressor will not be taken up.

Arrangement of Cylinders

IT is notable that in the vertical arrangement, either single-acting or double-acting pistons may be used, while for the horizontal arrangement the double acting is always used. In the single-acting vertical, the valves may be so arranged that gas comes in above the piston and is then compressed and discharged from above the

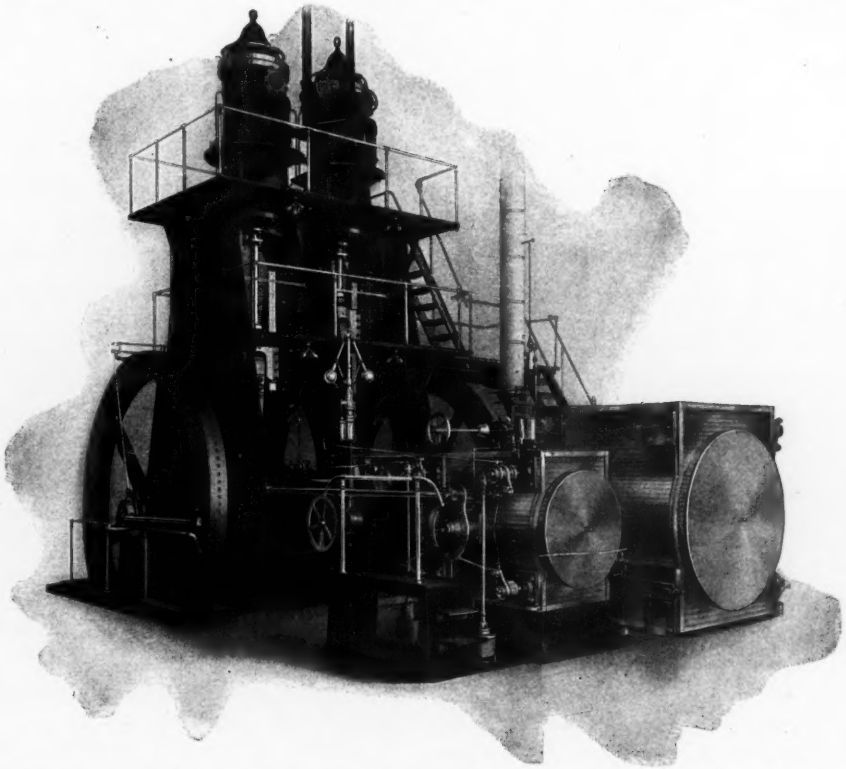


FIG. I. VERTICAL, DOUBLE-ACTING DE LA VERGNE TWIN COMPRESSOR DRIVEN BY HORIZONTAL CROSS-COMPOUND STEAM ENGINE

piston, or arrangement may be such that the ammonia is admitted through the lower end of the compressor cylinder and then passes through the piston into the upper end, and is compressed by the piston and forced out at the upper end of the cylinder through valves usually placed in the cylinder head.

Effort is usually made to keep the clearance as low as possible and in the vertical single-acting type the whole upper cylinder head is frequently made so that it may rise in case the piston should come against it or in case liquid should gather in the cylinder and fill the clearance space. The head is held in position by a spring, discharge being ordinarily through valves placed in the head, but in emergency the whole head may rise. There is, of course, a solid head which is held in position by bolts, the safety head being carried by one or more springs bearing against the fixed head.

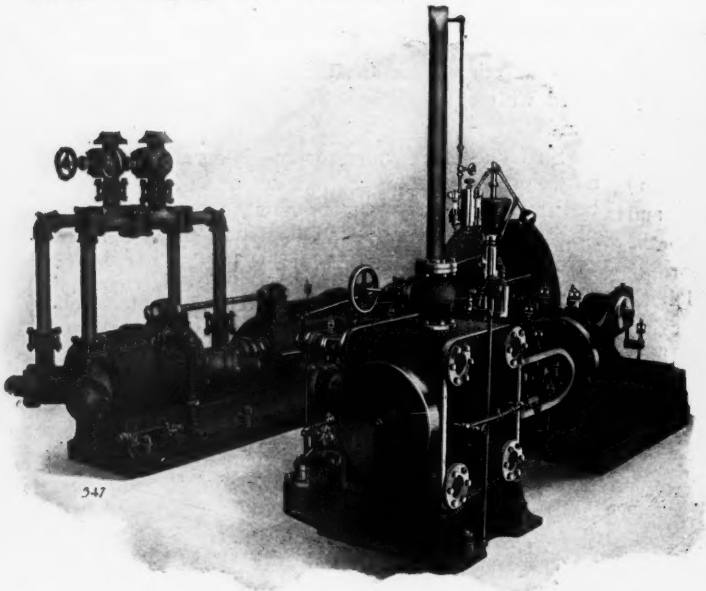


FIG. 2. HORIZONTAL, DOUBLE-ACTING YORK COMPRESSOR WITH CORLISS ENGINE DRIVE

An example of the last mentioned type of construction is seen in the York compressor cylinder shown in Fig. 3.

Gas enters at the bottom of the compressor, passing up through the suction valve in the piston, and is compressed and driven out by the up stroke of the piston through the discharge valve in the center of the safety head. As piston and head are faced off square and are so arranged as to come in contact with each other, the gas is completely discharged from the cylinder at each revolution. In case of accident or breaking of the valves, accumulation of liquid ammonia in the upper end of the cylinder or the presence of any obstruction, the safety head will lift against the force of the springs, thus saving a smash-up. The noise of the lifting head will attract the attention of the engineer, permitting him to shut the machine down and remedy the difficulty.

Around the compressor cylinder is a water jacket, water entering at the bottom and circulating around the walls and overflowing over the top cover, thus keeping the walls cool and taking care of a portion of the heat of compression. When compressing a dry gas, unless heat is taken out by water jacket or other cooling device, the gas will be superheated, and to keep the gas at the same temperature during the entire compression period, heat must be abstracted.

If heat is not abstracted the compression is adiabatic; that is, carried on without gain or loss of heat by the gas; if heat is abstracted to keep the temperature constant, the compression is isothermal, and less work is required during the compression period. There is also less heat in the gas at the end of compression, so that there is less cooling required by the condenser in bringing the ammonia back to a liquid form. As a matter of fact, even with water jacketing, heat is not abstracted as fast as it is given to the ammonia gas by the operation of compression, so that the gas actually is compressed on a line lying between the isothermal and the adiabatic, its exact position being determined by the temperature of the cooling water and the rapidity with which it flows through the water jacket.

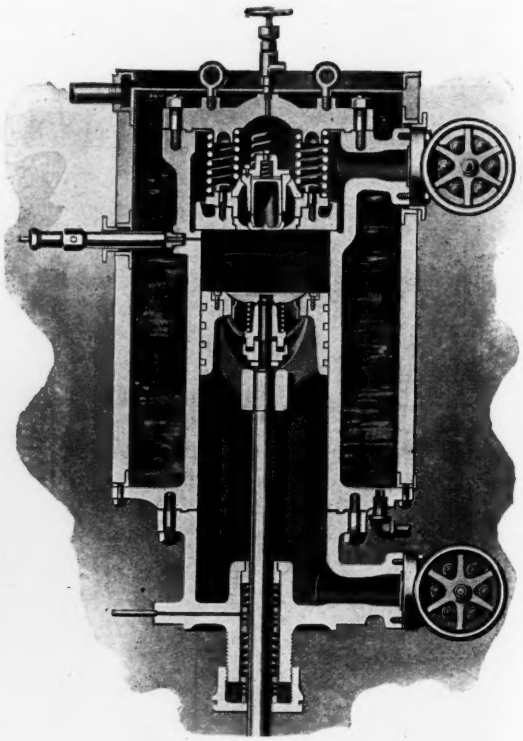


FIG. 3. SECTION OF YORK SINGLE-ACTING VERTICAL COMPRESSOR CYLINDER

In this compressor, the piston rod passes through a stuffing-box, but this stuffing box is in the low-pressure end of the cylinder and never has to carry the high compression pressure. Only a light pressure is therefore needed on the packing to prevent leakage of the ammonia gas along the piston rod. Midway of the stuffing box an oil compartment will be noticed into which oil may be introduced to lubricate the rod. Also into the upper end of the cylinder a small pipe is tapped to admit a small amount of liquid ammonia in case the cylinder should get overheated.

Small Power Compressor

ANOTHER type of compressor used for small size plants is shown in Fig. 4. This has a piston with solid head and of the trunk type, that is having the crosshead pin inside the piston. The valves are arranged in the upper cylinder head, one valve serving for admission and the other for discharge, and both being set flush with the head surface so that the piston may travel close to the cylinder head. The compressor

cylinder is surrounded by a water jacket and has provision by means of the small pipe at the left of the compressor cylinder for drawing any ammonia which may escape into the crank case out into the inlet pipe. Two cylinders are placed side by side with cranks set at 180 deg. apart to balance the inertia force of the 2 sets of reciprocating parts.

It is claimed by the manufacturers of this compressor that it will handle wet and dry gas equally well, that stuffing box leakage is avoided, that a clearance of 1/64 in. may safely be used.

It will be noted that in both the compressors shown, as well as in those which are to follow, the valves are arranged in cages so that the entire valve and its seat may be removed from the compressor for inspection and regrinding without breaking any pipe connections. In the York machine the valve is uncovered by removing the cylinder head, leaving the valve cages exposed. In the Larsen machine either inlet or discharge valve may be exposed by removing a cap held to the head by stud bolts.

Double Acting Double Compressor

TYPICAL of this form is the De La Vergne, shown in section in Fig. 5. Gas enters through suction valves shown on the left hand side at the top and bottom and passes out through discharge valves, which, for the

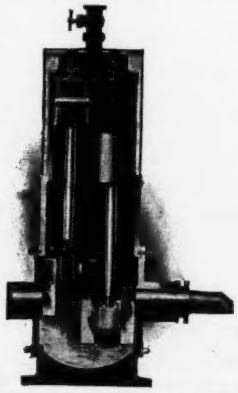


FIG. 4. SECTION OF LARSEN-BAKER COMPRESSOR

top end of the cylinder, are located in the head, and for the bottom end, on the right hand side. The suction valves are carried in cages which fit into recesses in the main cylinder casting, so that to inspect valves it is simply necessary to remove the bonnets and take out the valve housings.

Upper discharge valves and their guides are carried in a housing which covers the entire upper end of the cylinder and makes a gas tight joint with the cylinder. Above this housing is the main cylinder head, held to the cylinder casting by stud bolts, access to the valves being had by removing the upper cylinder head. Lower discharge valves are set in similar housings at the right hand lower side of the cylinder and may be examined by removing a bonnet which goes over the housing.

In the bottom of the cylinder and on the top of the piston will be seen a thin layer of oil called "liquid base" which is injected into the cylinder at each stroke after the charge of cold gas has been received. On passing into the cylinder, this charge of oil spreads in a thin layer and once in position serves the double purpose of eliminating leaks either past the piston or through the stuffing box, also lubricates both piston and rod.

On the upward stroke the charge of oil fills all clearances thus driving all gas out of the cylinder and, if there be an excess, a little may be forced over into the discharge pipe. On the downward stroke, gas is forced through the discharge valves at the side and after the ports are covered by the side of the piston, any remaining gas or excess of oil enters the piston through the valves shown in the bottom of the piston and thence through passage in the piston to the upper of the 2 discharge valves at the side of the cylinder. Oil is removed from the compressed ammonia gas either in an oil separator or in the fore cooler so that the oil is recovered, and after being subjected to a cooling process, may be used over again. The cylinder is not water jacketed, cooling of the

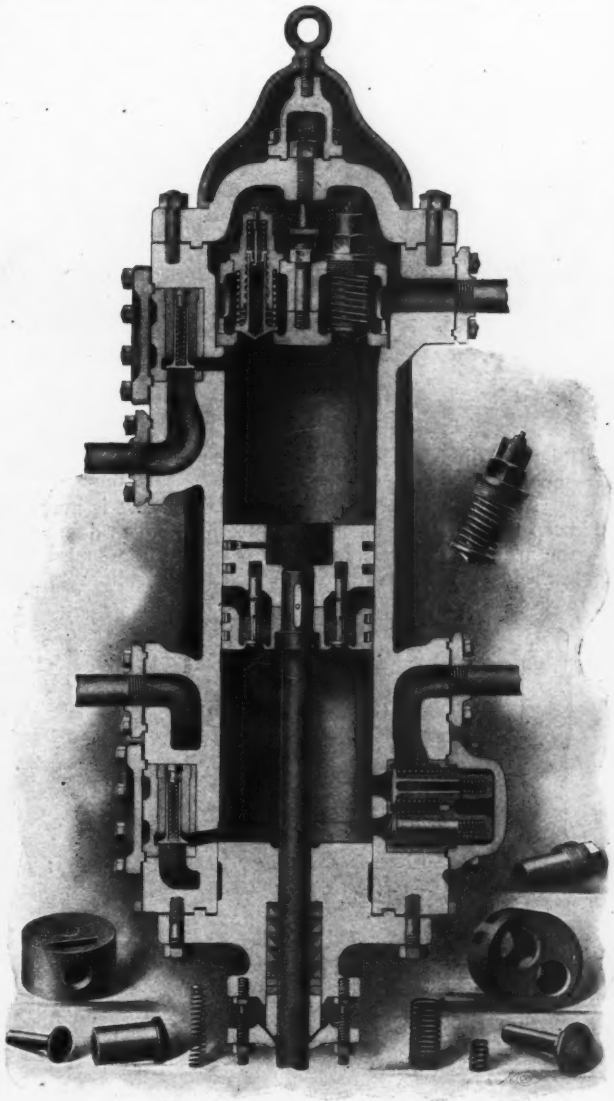


FIG. 5. SECTION OF DE LA VERGNE DOUBLE-ACTING VERTICAL COMPRESSOR CYLINDER

gas being accomplished by the injection of the cold oil and when necessary, by the use of a slight amount of liquid ammonia.

Horizontal Compressors

AS previously mentioned, these are all double acting, with discharge and inlet valves arranged at each end of the cylinder. The inlet valve is on top and the discharge valve at the bottom; in other cases the inlet valve

is at one side and the discharge valve at the other in a horizontal plane; and in still others there are 2 discharge valves and 2 inlet valves on each end of the compressor cylinder, the inlet valves being placed on top and the discharge valves at the bottom. In another type both inlet and discharge valves are placed beneath the cylinder, opening into the same port.

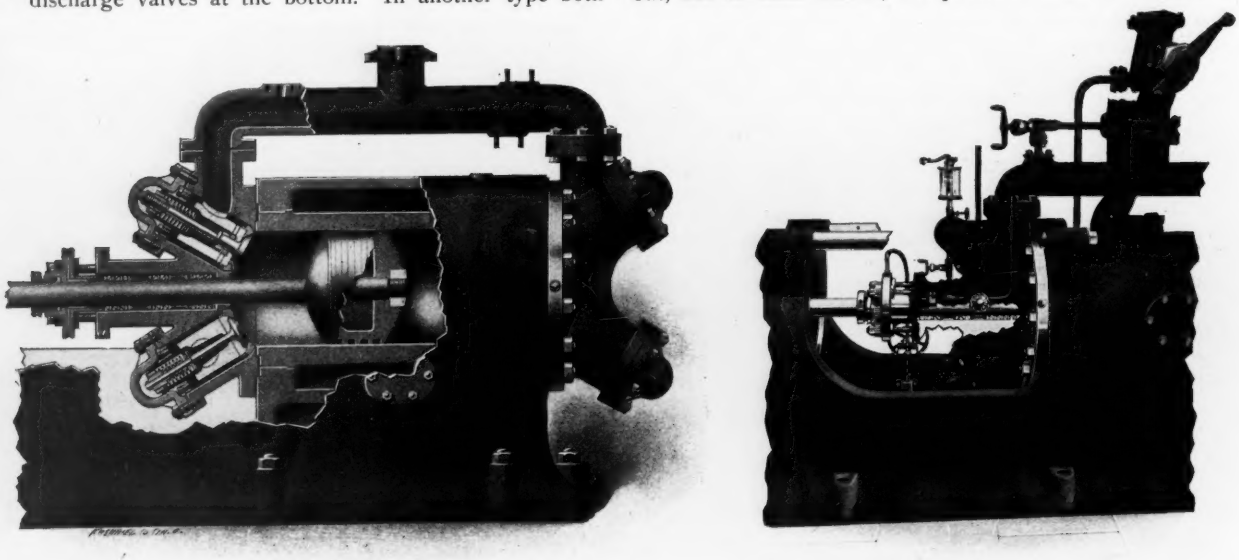


FIG. 6. VIEWS OF TRIUMPH HORIZONTAL COMPRESSOR

In most horizontal compressors the effort is made to keep the clearance as small as possible and in doing this the inside of the cylinder heads is turned to a sphere and the end of the piston to a corresponding sphere so that the 2 may approach closely. The valves are then set radially so as to conform as closely to the surface of the spherical cylinder end as possible.

The Triumph compressor shown in Fig. 6 has valves arranged above and below the piston rod, and placed in cages as in the case of the vertical compressor; these cages are accessible by removing bonnets which are bolted over the valve chambers. In this particular make of compressor the piston is of steel in a single piece cored out, but in other makes, the piston is made in 2 parts held together by a shoulder on the piston rod and nut on the end of the rod.

In all double-acting compressors the stuffing box through which the piston rod passes must carry the compression pressure and it is, therefore, necessary that this should be kept tight in order to avoid ammonia leakage.

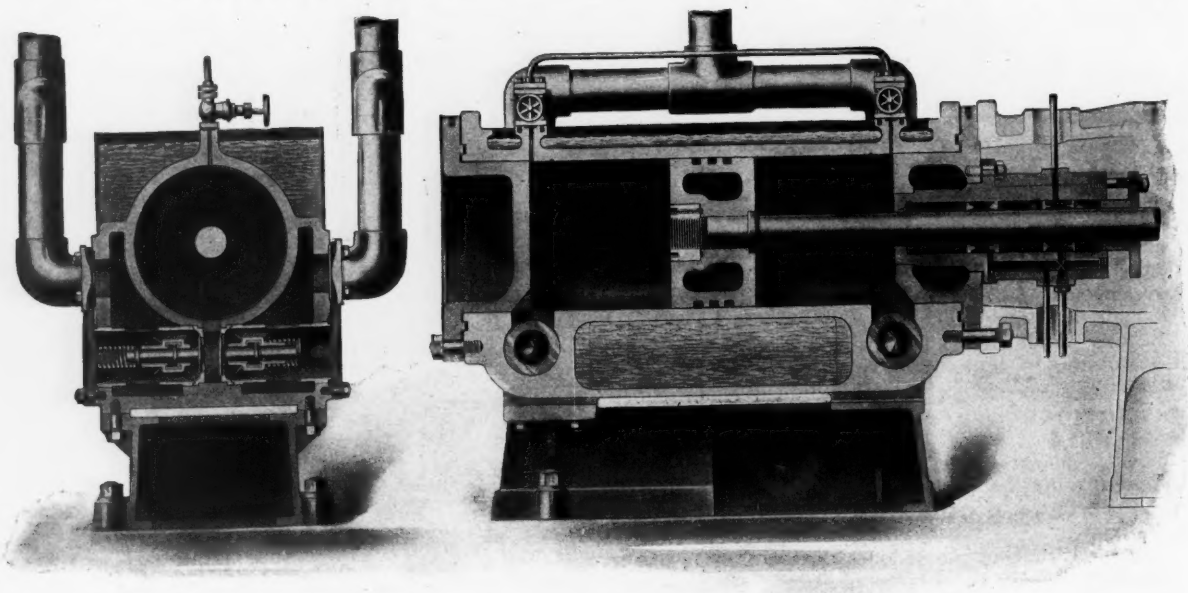


FIG. 7. SECTIONS OF HORIZONTAL DOUBLE-ACTING DE LA VERGNE COMPRESSOR

Some form of "lantern" arrangement is usually adopted, the lantern being a chamber into which ammonia gas may expand as it passes along the piston rod and from which this gas may be drawn off and carried back, usually to the suction manifold above the compressor cylinder.

In the case of the Triumph compressor 2 such lanterns are introduced and outside of these an oil chamber into which oil may be pumped. The sectional view of the compressor cylinder shows the construction of this packing and in the view of the stuffing box is shown the pipe for carrying the ammonia to the manifold and also the method of lubricating the rod.

In the York horizontal compressor, shown in Fig. 2, the valves are arranged horizontally, and in larger size machines of the same make, 4 valves are used.

In Fig. 7 are shown views of the De La Vergne horizontal compressor which is horizontal and double-acting and has the valves arranged below the cylinder. Ammonia is admitted to the compressor cylinder through the main which branches to the 2 ends of the cylinder. The suction valves are located in recesses, one at each end of the cylinder, and these recesses also communicate with the discharge valves through which the compressed ammonia vapor passes into the pressure main.

The ports are arranged opposite the valves, leaving a space between the valves and on top of the cylinder which is water jacketed. While this arrangement of valves introduces a certain amount of clearance, the makers think that the expansion of this clearance gas from compression pressure to inlet pressure cools down the cylinder head and valves and in this way reduces the amount of work required for compression by keeping the entire machine at a lower temperature than would be the case if no gas were expanded in the cylinder.

An advantage claimed for this arrangement is that by no possibility can the valves get into the cylinder should the parts become broken.

In this compressor a slightly different arrangement of piston rod packing is used containing one lantern for catching the ammonia gas and an oil chamber for the introduction of lubricating oil. As in other types, the valves are contained in cages and are removable by taking off a bonnet over the valve chamber.

REMEDYING TROUBLE OF A SLIDE VALVE ENGINE

ABOUT 40 years ago the writer was called into an engine room of an old-style grain-handling establishment and asked if he could remedy a defect in an engine that almost stopped when the load was thrown upon it. Several attempts had been made to correct the fault without result. The steam pipe was 1¼ in. in diameter and about 300 ft. long, with considerable condensation, and the engine operated at about 180 r.p.m. without load.

On inserting the light into the steam chest, above the upper edge of the valve, 3 holes were apparent. The engine having a side chest, the valve worked on one edge and rust caused by condensation, together with the natural wear, had worn the lower edge of the valve rapidly until the 3 ports were exposed about 3/16 in.

The valve was taken out and placed in a drill press and 4 ¼-in. holes drilled in the bottom edge and a suitable piece of strap iron, thick enough to raise the valve to its proper place, was secured to the valve with rivets. The valve was replaced in the original position and the engine worked without difficulty and pulled a good load.

THE COST OF FIRES each year is one-half the cost of all the new buildings erected in a year.

STEEL BELTS

Some Important Applications in Europe

IN applying steel belts as now used in Europe, great care is necessary to get the right length, as too little stress results in great slip, while too much causes excessive friction and shortens the life of the belt. The length is, therefore, determined by a steel tape which is carried around the pulleys and put under the same tension per square inch of cross section that the belt is to have. The tape is then cut to exact length without overlap, and on removal it contracts so as to give the right length for the unstrained belt to be cut.

Steel belts properly installed are said to have a useful life exceeding 5 yr.

Some actual drives installed have been: a 1300-hp. transmission by means of 3 belts each 4¾ in. wide, pulleys 122 and 63 in. diam. at 226 and 500 r.p.m. respectively and 46 ft. centers; a 75-hp. drive with belt 6 in. wide on pulleys 9 ft. and 4 ft. 3 in. diam. at 6 ft. 4 in. centers; a dynamo drive of 350 hp. by 2 bands each 6 in. wide on steel plate rims 6.7 in. wide; the smaller pulley was 54 in. diam. at 360 r.p.m., the larger 95 in. at 200 r.p.m. and the distance on centers 18 ft. 8 in.; this belt replaced 11 ropes.

Steel bands have lately replaced cotton-rope drives in a number of important applications. In the first conversions effected, the rope pulleys were filled in with wood to give a cylindrical running surface for the steel bands. This arrangement, though perfectly satisfactory, was costly, and in the method since employed, a stout steel band is strained round the pulley rim and fastened by a clamp similar to that used for the driving band. The smooth cylindrical surface thus formed is serrated and provided with a friction covering in the ordinary manner.

Over 10,000-hp. of cotton-rope drives has already been converted to steel-band transmissions. The existing pulley diameters and shaft separations are excellently suited to the direct substitution of steel driving bands. The conversion usually increases the horsepower available at the driven shaft by 7 to 10 per cent, this being the result of a number of tests in actual installations.

As a substitute for leather and cotton belts, steel bands are preferably confined to high-power, low-speed transmissions over relatively small shaft pitches. Crossed steel belts are satisfactory if the point of crossing is not less than 60 to 70 band widths from both pulleys. Since the driving and driven pulleys may almost touch, even when transmitting high power by steel bands, the latter form an excellent substitute for gear-wheels—giving a smoother and more efficient drive than can be attained by any other means. The axes of a number of shafts driven from a single main pulley may be in one vertical plane, or a number of shafts in one horizontal plane may be driven by a series of steel belts close together (the small sag of the latter avoiding the risk of fouling).

Isolated instances of defects in material, leading to band breakage 4 or 6 weeks after installation, are still to be found, and though their number is steadily diminishing, spare bands should be kept ready for immediate fitting to important drives. Owing to the lightness of steel bands transmitting a given power, the protective network of wire lattice may be much lighter than would be required to safeguard the equivalent leather or woven belt.

ELECTRIC MOTOR CONTROL

Devices Used for Starting, Stopping, Reversing, and Regulating the Speed of Direct and Alternating Current Motors

CONTROL OF ELECTRIC MOTORS is one of the most important features of industrial and power work, and involves many problems that require careful consideration. The selection of the proper form of control for any given condition of operation is fully as essential as the choosing of a motor of the correct type to perform the work required of it.

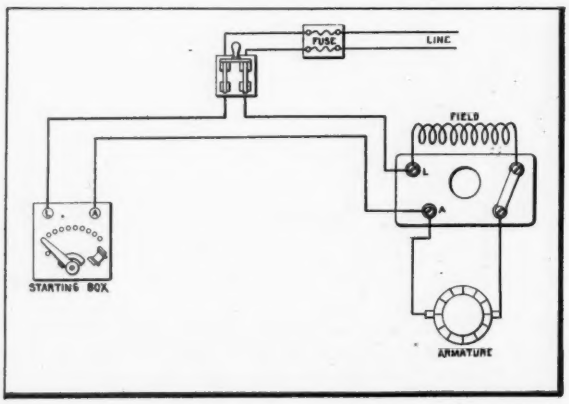


FIG. I. SPRAGUE-GENERAL ELECTRIC SERIES-WOUND MOTOR WITH CUTLER-HAMMER STARTING RHEOSTAT

Characteristics of direct and alternating-current motors were fully discussed in the Jan. 15, Feb. 1, and Feb. 15 issues of Practical Engineer under the respective titles of "Direct-Current Motor and Generator Troubles," "Motor and Generator Troubles," and "The Installation, Operation and Care of Induction Motors."

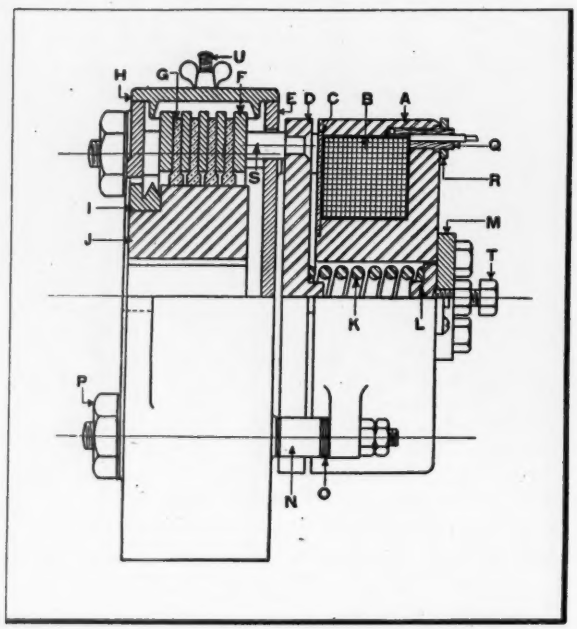


FIG. 3. DETAILS OF A MAGNETIC BRAKE

Elementary diagrams of the motor connections were shown. It is the purpose of this article to illustrate and describe modern commercial methods of motor control in general use, for both direct and alternating-current systems.

The wiring connections of the more complicated methods of control are somewhat intricate, and if the electrician or engineer does not have drawings at hand, repairs to the apparatus involve the necessity of making a sketch when dismantling it; under such conditions there is always a chance for error.

Direct-current motor control apparatus is considered first, in its logical sequence of types including series, shunt, compound, inter- or commutating-pole, elevator and mill-type motors, followed by special types which include the mutiple-voltage system and motor generator sets with flywheels.

The starting and controlling devices for alternating current motors include those for single-phase motors

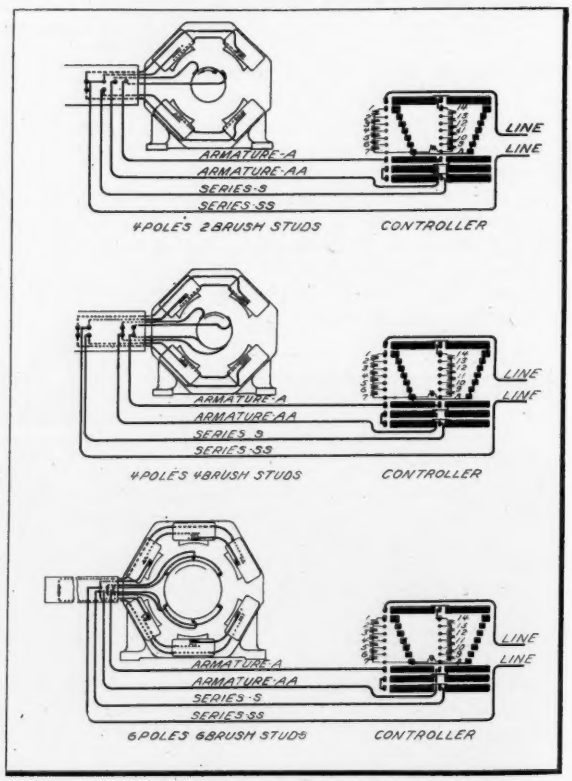


FIG. 2. CONNECTIONS OF CROCKER-WHEELER SERIES-WOUND MOTORS AND REVERSING AND REGULATING CONTROLLERS

with two and three-phase windings, repulsion-induction motors, and polyphase induction motors of the squirrel-cage, internal resistance, and external resistance types, and synchronous motors.

Series Wound Motors

WHEN series-wound motors are to be operated in one direction at constant speed, the starting devices consist of an ordinary starting rheostat with a no-voltage release, and a main switch as shown in Fig.

1. To start the motor, the main switch is closed first, then the lever of the rheostat is thrown over to the right-hand position against the no-voltage release magnet which is connected in series with the circuit. This magnet attracts an iron armature attached to the lever, holding it in the running position against the resistance of a spring. When the circuit is opened, or if the current is interrupted from any outside source the magnet loses its energy and the lever will be re-

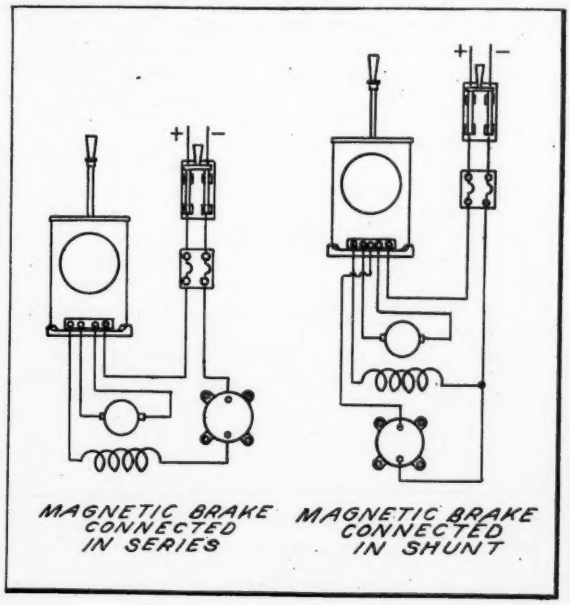


FIG. 4. WIRING DIAGRAMS OF CONTROLLERS IN CONNECTION WITH MAGNETIC BRAKES

turned to the "off" position by the action of the spring. If some such arrangement was not used, the lever might be carelessly left in the running position

FIG. 5. CROCKER-WHEELER SERIES-WOUND MOTOR WITH SOLENOID BRAKE

and upon closing the main switch there would be a sudden rush of current which would burn the commutator at the point of contact with the brushes and "blow" the fuses.

Release magnets are employed in all types of modern starting rheostats; some types of starting rheostats are also provided with an overloaded release magnet which releases the lever when a predetermind load has been reached thus preventing the "blowing" of the fuses and protecting the motor from overload. This second device is not essential however, where circuit breakers are used, as the time element does not enter into the opening of the circuit breaker as it does with the "blowing" of fuses.

It must be borne in mind that with a series-wound motor the resistance of a regulating rheostat or controller is connected in series with the motor armature and the field winding, therefore, the regulation of speed is dependent entirely upon the load the motor

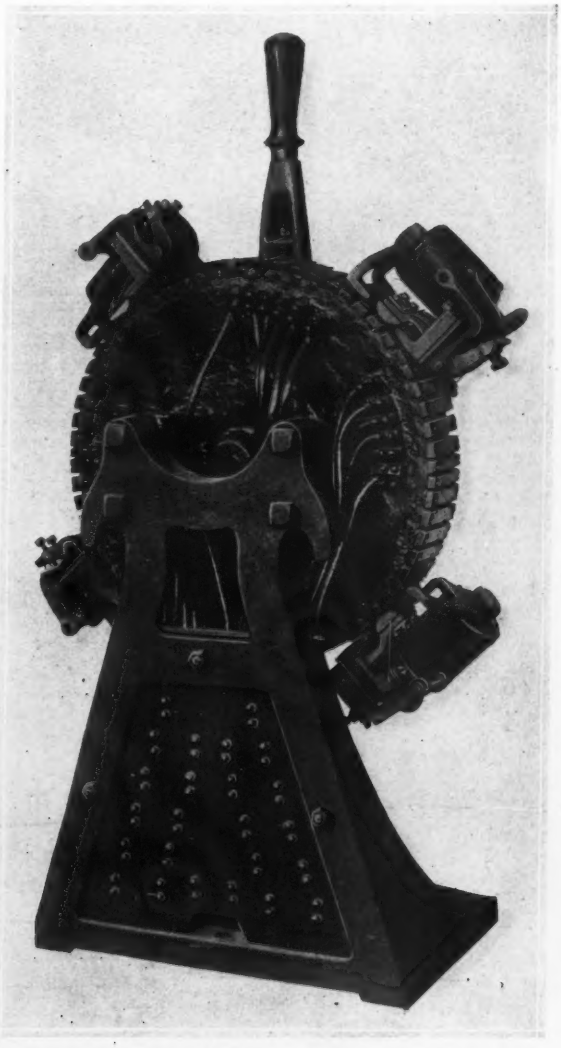


FIG. 6. WESTINGHOUSE "GRINDSTONE" TYPE CONTROLLER —FRONT VIEW

is carrying. If the load should suddenly be released the motor would race.

For the operation of cranes, hoists, turn-tables and similiar apparatus series-wound motors are controlled by a regulating and reversing controller. Fig. 2 shows the connections of a Crocker-Wheeler controller of this type connected to a 4-pole 2-brush stud motor of the same make; the connections of a 4-pole 4-brush stud motor and a 6-pole 6-brush stud motor are also shown in the same figure.

The controller handle when moved either to the right or to the left, gradually cuts out increments of resistance and in each case reverses the direction of the motor, by reversing the direction of the current through the field magnet winding or the armature, the method employed being immaterial.

Brakes for Series Motors

IN practically every hoist and crane proposition, load sufficiently heavy to overhaul the motor and driving mechanism has to be lowered at times and in the majority of cases this condition has to be met as often as a load is hoisted. It is now common practice, however, to use a magnetic or dynamic breaking device; the details of a magnetic brake for use with a series wound motor are shown in Fig. 3. In the figure the letters represent the various parts as follows: A, magnet case, special steel; B, coil, form wound and impregnated; C, retaining plate, brass; D, armature plate, steel; E, friction case, cast iron; G, friction plate, rotating brass; H, cover, cast iron; I, oil slinger, cast iron; J, hub steel (keys cut on hub); K, spring, steel; L, spring cap, cast iron; M, spring cover, cast iron; N, plate stud; O, distance washer; P, plate stud nut; Q, terminal bushing; R, termnal guard; S, armature spud; T, adjusting screw; U, cover clamp.

Figure 4 shows how magnetic brakes may be connected in several combinations. Solenoid brakes are frequently used which release a band brake that normally grips a drum or pulley. Fig 5 shows a Crocker-Wheeler motor equipped with such a brake.

The "Grindstone" type of controller used extensively in connection with direct-current motors operating cranes, hoists, steel mill machinery, etc., has proven eminently satisfactory. As shown in the illustrations Figs. 6 and 7, the controller consists essentially of a cast-iron frame on which is mounted a stationary disk carrying the contact pieces and cross connections. Pivoted to the center of the disk is the switch arm with 4 brushholders. The resistors can either be mounted on the frame or separate from it.

Controllers of this type have recently been placed on the market in which the disk is made of concrete

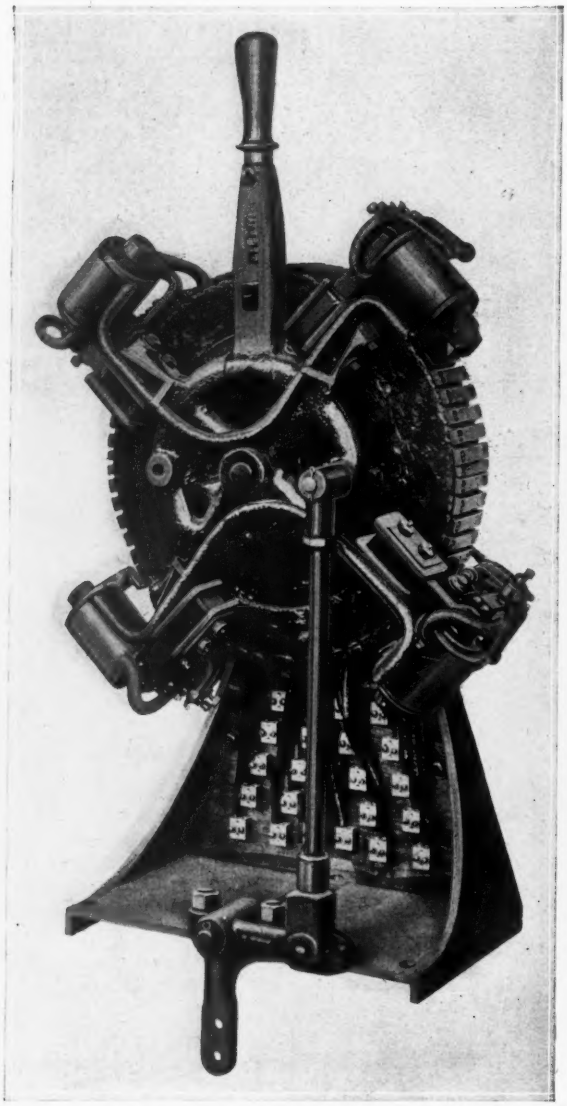


FIG. 7. WESTINGHOUSE "GRINDSTONE" TYPE CONTROLLER —REAR VIEW

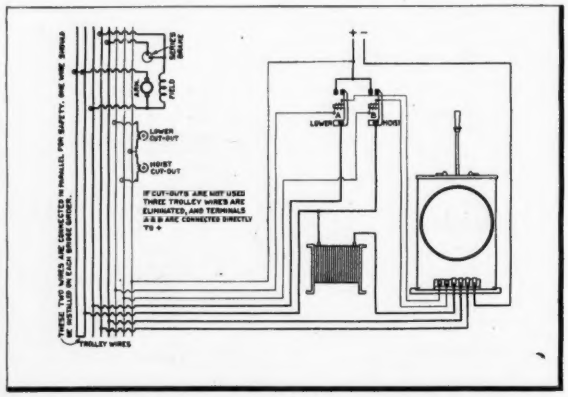


FIG. 8. CONNECTION DIAGRAM OF THE ELECTRIC CONTROLLER & MFG. CO'S. DYNAMIC BRAKING CONTROLLER

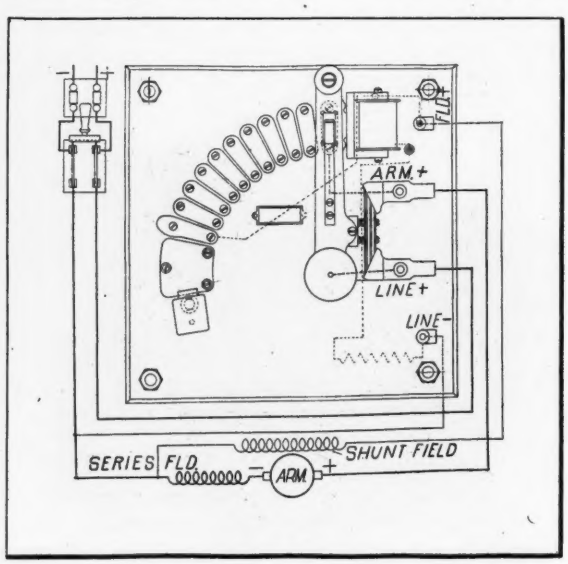


FIG. 9. STARTING RHEOSTAT CONNECTED TO A COMPOUND-WOUND MOTOR

instead of stone. By a special treatment, the concrete disk is made a thorough nonconductor and at the same time moisture resisting. The use of concrete permits the cross connections between the segments to be made within the body of the disk.

The dymanic braking controller operates the motor as a series machine in hoisting and converts it into a shunt motor when lowering. In the dynamic controller, lowering is accomplished either by power or dynamic braking, depending on whether or not the load is sufficiently heavy to overhaul the motor and driving mechanism. The speed of any load from the empty hook to the full capacity of the hoist can be controlled with a degree of fineness not obtainable in any other type of controller. This selection of power for dynamic braking is entirely automatic and independent of the operator. There is no special position of the arm nor any special contacts for obtaining dynamic braking, and in fact, the operator need not know whether the load is being lowered by power of by dynamic braking. Every well designed hoist has a magnetic brake as well as a mechanical or lowering brake, and as dynamic braking will not actually stop a descending load, it is necessary that the magnetic brake be capable of stopping and holding it. This brake action comes into use, however, only when the

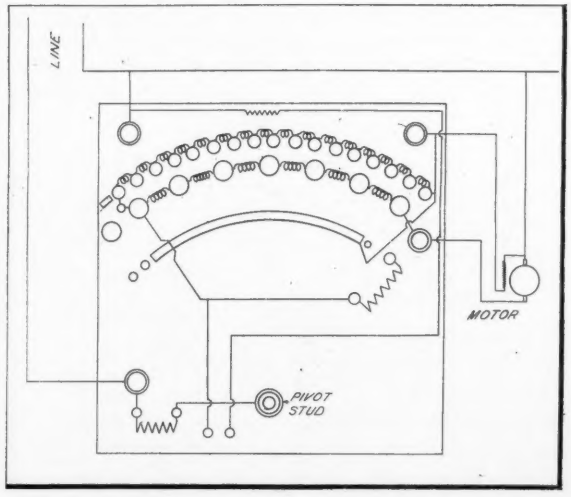


FIG. 10. CONNECTIONS OF A STARTING AND REGULATING RHEOSTAT

load has been brought almost to rest, so that the brake is subjected to practically no wear. For the best results this brake should be series wound.

When the off position of the dynamic controller is reached the motor is, of course, disconnected from the line, but is not open-circuited. The armature, series field and a small amount of resistance are connected in a local dynamic braking circuit, so that the heaviest load would descend slowly if for any reason the magnetic brake failed, thus preventing any damage. The dynamic braking circuit also prevents the load from gaining speed if the magnetic brake is slow in setting. Fig. 8 shows the connections of a dynamic-braking controller.

Shunt, Compound and Inter-Pole Motors

ELEMENTARY connections of a shunt wound, a compound wound and an inter-pole motor were shown in the Jan. 15 issue of Practical Engineer. The speed of shunt-wound and compound-wound motors may be varied over a considerable range by the introduction of resistance in circuit with the shunt-field winding. Inter-pole or commutating-pole motors have a wide range of speed variation. Shunt and compound-wound motors that operate at constant speed are generally started with a starting rheostat. These rheostats are made of several styles and all standard types have a no-load release and are often provided with an overload release. Fig. 9 shows the connec-

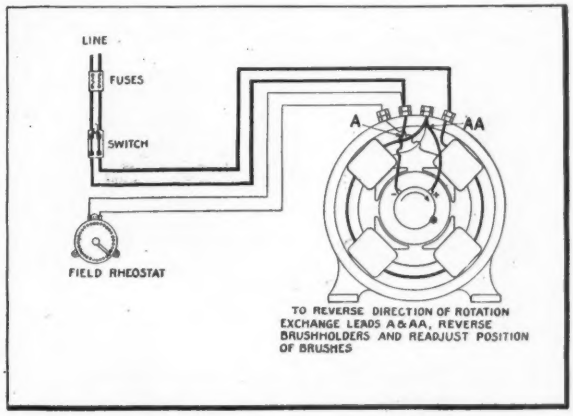


FIG. 11. CONNECTIONS OF A FIELD RHEOSTAT TO MOTOR FOR SPEED VARIATION BY FIELD WEAKENING

tions of a starting rheostat with a compound-wound motor; this rheostat is provided with a no-voltage release.

Figure 10 shows the connections of a starting and regulating rheostat with a no-voltage and an overload release. Two arms are pivoted to the same post, the one nearest the faceplate being the starting lever and the other above it, the speed-regulating lever.

The motor is started in the usual manner, the lever being moved over to its running position by the

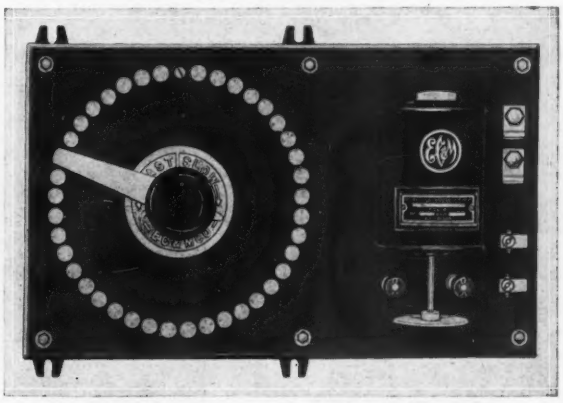


FIG. 12. ELECTRIC CONTROLLER & MFG. CO'S. FIELD RHEOSTAT WITH RELAY

handle on the speed lever which engages a pin on the starting lever near the pivot. When the arm reaches the first position in the armature circuit, it also makes contact with the sector beneath the row of starting contact buttons and short-circuits the field regulating resistance, thereby giving full field strength. When the lever reaches the full-speed position, it leaves the sector and releases the field resistance to the control of the other lever which may then be moved to any position in its travel.

The latter lever connects with the upper row of buttons which are tapped to the field regulating resistance. When the release magnet lets go, the starting arm is thrown back to the "off" position and carries with it the field regulating arm. The release magnet is connected in series with a resistance across the line.

Figure 11 shows the connections of a field rheostat to a motor for speed variation by field weakening. In

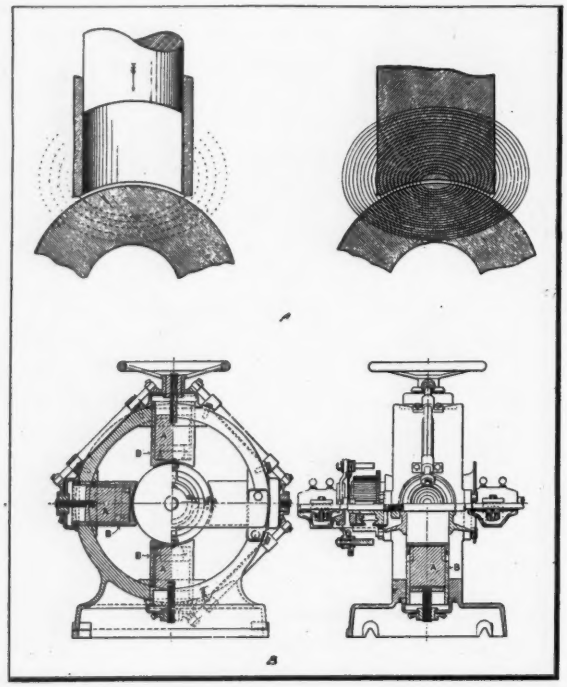


FIG. 13. DETAILS OF STOW MOTOR. A, CROSS MAGNETIZATION OF POLE PIECES DUE TO ARMATURE REACTION; B, PLUNGER MECHANISM

the operation of adjustable speed, shunt-wound motors in which changes of speed are due to field regulation,

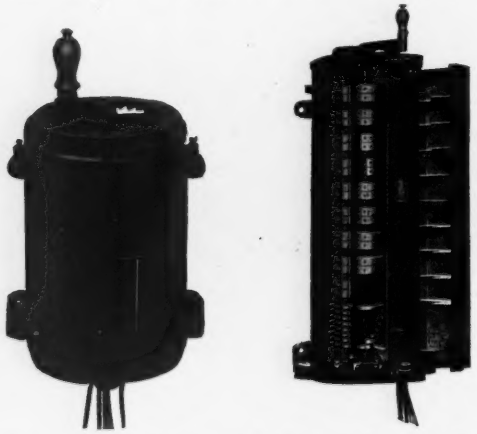


FIG. 13A. WESTINGHOUSE MACHINE TOOL CONTROLLER FOR SMALL ADJUSTABLE SPEED MOTORS

FIG. 14. WESTINGHOUSE MACHINE TOOL CONTROLLER FOR USE WITH LARGE ADJUSTABLE SPEED MOTORS

it is highly desirable to have full field strength in starting the motor. If, through neglect, the resistance is left in circuit with the shunt-field winding, the starting current becomes dangerous to the motor. This is due to the fact that on account of the weakened field, the torque exerted by the motor is too small to allow the motor to start normally, and, as the starting resistance is cut out, an excessive current flows through the armature, causing destructive sparking at the commutator and liability of serious overheating of the armature windings and motor starting resistance.

To prevent such conditions the Electric Controller & Manufacturing Company has developed a rheostat relay to prevent starting the motor with a weakened field. This relay consists of a magnet coil or solenoid through which passes a steel plunger carrying at its lower end a contact plate for electrically connecting the 2 contact studs. The magnet coil and plunger are enclosed in an iron case which serves not only for portection, but acts as a part of the magnetic circuit.

Relay coil is connected with the armature circuit of the motor, and the two contact studs are connected to the terminals of the motor field rheostat so that the rheostatic resistance is short-circuited when the contact studs are bridged by the contact plate. It is so designed that, when the armature current exceeds a predetermined maximum, the plunger is drawn up, causing the contact plate to connect the 2 contact studs, thus cutting out all of the resistance in series with the shunt field giving the motor its full field strength and consequently maximum torque, enabling it to accelerate its load properly. As the current de-

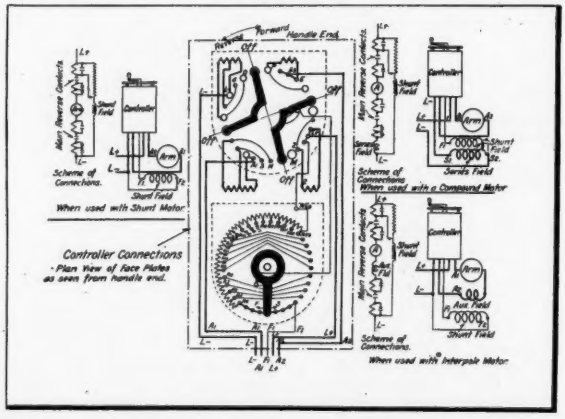


FIG. 15. CONNECTION DIAGRAM OF WESTINGHOUSE TYPE 483 CONTROLLER

creases, due to the speeding up of the motor, the relay plunger drops, inserting the rheostatic resistance in the shunt field winding. This cycle of operations is repeated until the motor has been safely brought to the proper speed as determined by the setting of the motor field rheostat. Figure 12 shows a motor field rheostat and relay.

The speed of a motor may be varied by mechanical means, as illustrated by the Stow motors. These motors are of the "constant output" type, that is, they will carry their full rated load at any speed within range as the capacity of the motor is not increased by increasing the speed, nor reduced by reducing the speed.

Improved results are secured by the special construction of the pole piece, which is made hollow and is provided with a large iron core or "plunger" adjustable by means of a screw threaded handwheel. Sectional views, Fig. 13, show the manner of moving the plungers in and out of the multipolar motors.

In the ordinary motor with solid or laminated poles, there are 2 separate and distinct conditions which make it impossible to obtain a wide speed range by weakening the field strength; first, the weakening of the commutating field at the pole tips, and second, the cross magnetizing effect of the armature reaction which acting transversely through the pole distorts the magnetic field and shifts the "neutral" line. Both these conditions cause sparking at the brushes.

In the Stow multi-speed motors, however, the operation is such that as the plunger is being withdrawn the air column within the pole piece offers a gradually increasing barrier to the cross magnetizing effect of the armature, until when the field strength is reduced to minimum by fully withdrawing the plunger, the armature reaction is also reduced to a minimum from lack of a conducting path through which to act. Again, the construction of the pole piece and plunger is such that, as the volume of magnetism is reduced by the outward movement of the plunger, the remaining magnetic flux is forced more and more in the direction of the pole tips, thus furnishing a magnetic field at all times of sufficient intensity to insure sparkless operation at the commutator.

Like the ordinary shunt motor with field regulating rheostat, these motors owe their speed regulation to the variation of field strength; but, unlike the common shunt motor, the flux at the pole tips utilized in commutation is, by the special construction, maintained practically constant, irrespective of the changes of total flux acting on the armature.

The pole piece comprises a shell over which the magnetizing coil is wound, and within which is a solid core of high permeability and of a crosssection relatively large as compared with the conducting area of the enclosing shell. By means of a handwheel this inner core or "plunger" is adjustable in a direction radial to the center of the armature, and is so arranged

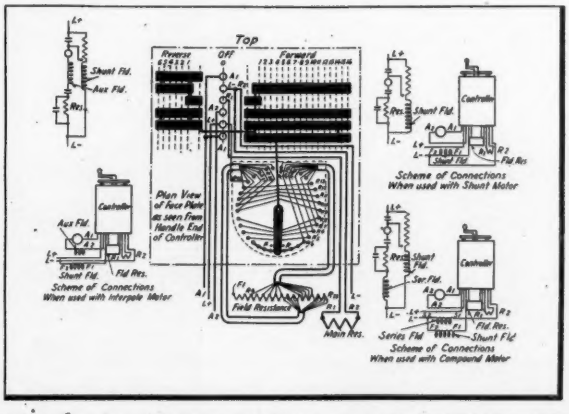


FIG. 16. CONNECTION DIAGRAM OF WESTINGHOUSE TYPE 245 CONTROLLER

that a slight variation in its position within the magnetized shell produces a very considerable difference in the reluctance of the magnetic circuit of which the plunger forms a part.

When the plunger is adjusted so that its inner end comes nearest the armature, the magnetic circuit is nearest complete and of minimum reluctance, and, since the current in the field coil remains constant, the volume of magnetic flux becomes a maximum and the speed minimum. As the plunger is being drawn away from its innermost position a colmun of air is interposed which gradually increases the reluctance of the magnetic circuit as long as the plunger continues to be withdrawn. When the plunger reaches the limit of its outward motion the reluctance of the magnetic circuit, and hence the speed, becomes maximum.

To those familiar with the action of field regulated shunt motors of ordinary type a variation in speed of 200 per cent by a corresponding variation of the magnetic flux would seem impossible of realization on account of the difficulty of securing sparkless communication when the field strength of the motor is so abnormally reduced. It should be remembered, however, that the sparking is not due to the reduction in total magnetism, but is due to the reduction of magnetic strength at the pole tips only. It becomes apparent,

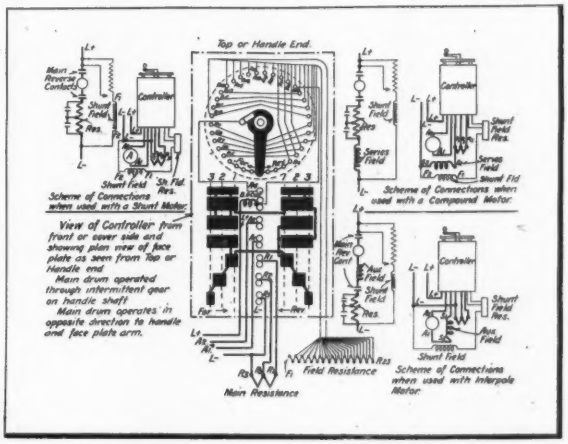

Top or Handle End
Scheme of Connections when used with a Shunt Motor
View of Controller from front or cover side and showing plan view of face plate as seen from Top or Handle end
Main drum operated through intermittent gear on handle shaft
Main drum operates in opposite direction to handle and face plate arm.
Field Resistance
Main Resistance
Scheme of Connections when used with a Compound Motor
Scheme of Connections when used with Interpole Motor

FIG. 17. CONNECTION DIAGRAM OF WESTINGHOUSE TYPE 246 CONTROLLER

therefore, that if any means are employed by which to maintain a practically constant strength of magnetism at the pole tips, the speed could then be varied over a greatly increased range without causing sparking at the commutator. This desirable condition is realized in the special construction of pole piece, its action being to force a gradually increasing proportion of the total magnetism down to the pole tips as the plunger is withdrawn, the entire flux being delivered directly at the pole tips when the plunger is fully withdrawn. A commutating field of sufficient intensity to secure sparkless commutation, under full load, over a wide range, is thus obtained.

In these motors no resistance whatever is utilized in accomplishing the speed control, and therefore the efficiency is practically uniform throughout the entire range of speed. Owing to the absence of auxiliary resistance, the hp. capacity is the same for all speeds, and the speed practically constant under changes of load.

Once adjusted to the required speed, these motors **operate at practically constant speed**, whether the motor is running light or under full load. The amount of speed reduction due to the load is the same in the Stow motor as in standard shunt-wound, constant-speed motors, taking constant voltage direct from the line, the exact drop in speed depending on the size of the motor.

Machine Tool Controllers

CONTINUOUS movement of the operating handle in either direction first starts the motor in the corresponding direction of rotation, then cuts out the starting resistance, and finally cuts in the field resistance until the desired running speed is reached. The

handle must be moved over the starting notches in not over 15 sec. for motors under 10 hp. and not over 30 sec. for larger motors. The starting resistance must not be used for speed control.

For a quick stop when operating with weakened field, move the handle quickly to the first running notch, hold it there momentarily and then move it to the off position; the application of full field strength when the speed is high causes dynamic braking, thus

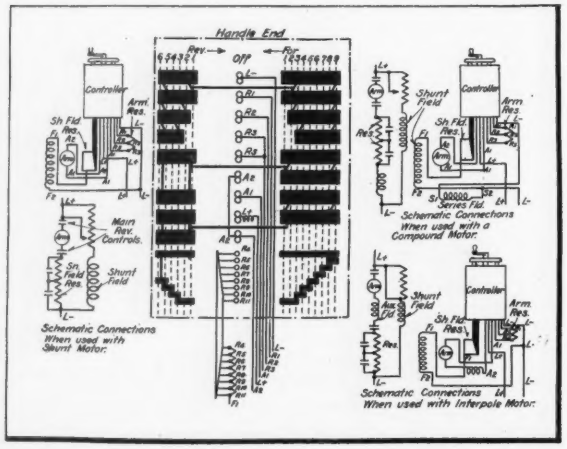


FIG. 18. CONNECTION DIAGRAM OF WESTINGHOUSE TYPE V-4 CONTROLLER

checking the speed quickly and without shock. For an emergency stop, the handle can be moved to the first reversing notch after checking the speed by dynamic braking, but as this operation causes severe mechanical and electrical stresses, the reversing should never be carried beyond the first notch. When the motor is to be at rest for any length of time, open

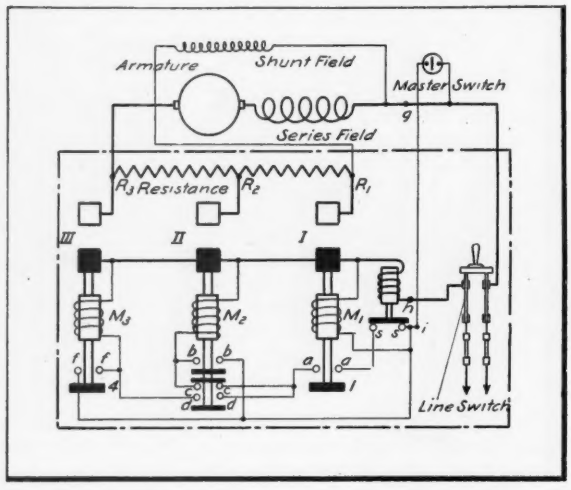


FIG. 20. DIAGRAM SHOWING METHOD OF ACCELERATION BY SERIES RELAY

the line switch. Figs. 13 and 14 show 2 types of this controller. Figs 15 to 18, inclusive, give the connections of 4 types as used with a shunt-wound, a compound-wound and inter-pole motor.

Magnet Switch Controllers

MAGNET switch controllers consist essentially of a group of electro-magnetically actuated switches. The switches are operated by shunt magnet coils; their action can be manually or automatically governed. Fig. 19 gives a cross-sectional view of 2 sizes of Westinghouse magnet switches. The rate of acceleration is controlled by a series relay the operation of which will be understood by reference to Fig. 20. The diagram shows a compound-wound motor connected to a 3-point magnet-switch controller with a one-point master switch. The magnet switches are shown at M1, M2 and M3 the main contacts at I, II, and III, and the interlocking contact at 1, a, b, etc. Main circuits are shown in heavy lines and interlocking circuits in light lines.

The series relay, h, is a small electro-magnet, the plunger of which carries a contact disk which normally spans 2 stationary contacts s-s, in series with the magnet coil interlocking circuit. The magnet coil is connected in series with the main circuit and the amount

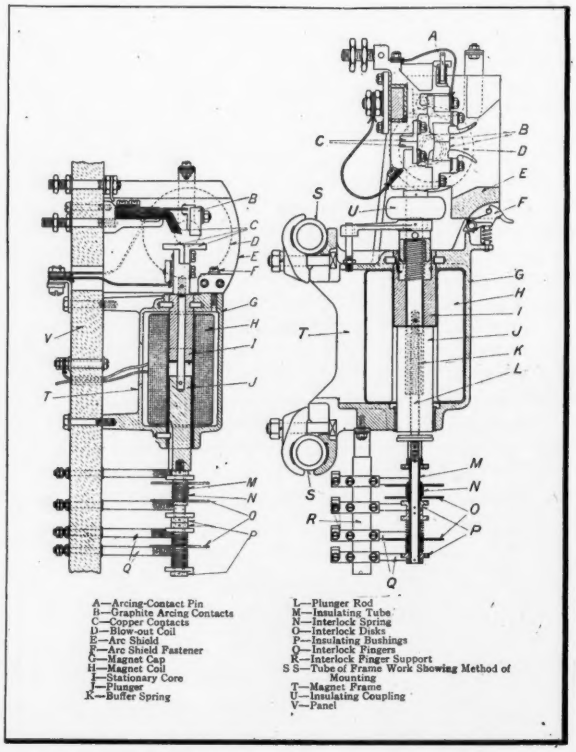


FIG. 19. SECTIONAL VIEWS OF TWO TYPES OF WESTINGHOUSE MAGNET SWITCH CONTROLLERS

of current required to lift the plunger can be adjusted by weights on the plunger.

It will be noticed that the line switch in the diagram does not close either the motor or the magnet switch circuits; operation does not begin until the master switch is closed. Closing the master switch connects coil M1 across the circuit; the plunger rises closing contact I and bridging a-a with disk 1. The motor starts and the high starting current causes the series relay to open gap s-s, in the control circuit. As soon as the motor current falls to a point predetermined by the relay adjustment, gap s-s is closed, and coil M2 is connected across the line through s-s, a-a and c-c. Contacts II are then closed; interlocking contacts b-b and d-d are bridged and gap c-c is opened. Contacts II short-circuit resistance R2-R1 causing an increase in the motor current, so that the series relay again open s-s. But the opening of c-c and the closing

of b-b has meanwhile connected M2 across the circuit independent of the relay, so that though the relay can delay the closing of a magnet switch, it has no control over one already closed. When the starting current decreases, gap s-s is again closed; coil M-r is energized, closing contacts III and connecting the motor directly

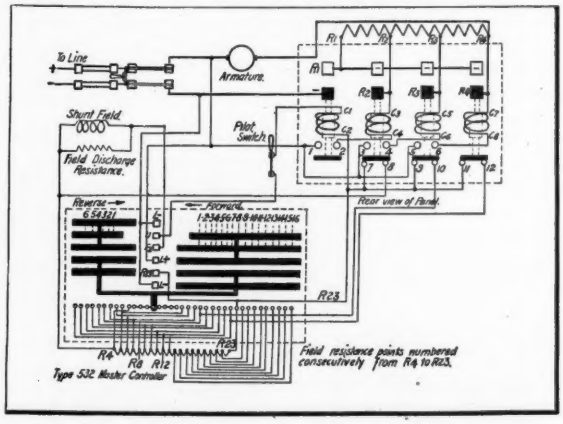


FIG. 21. CONNECTION DIAGRAM OF PUSH-BUTTON CONTROLLER

across the line. The gap f-f is bridged with contact 4, so that the coil M3 is removed from any further control by the relay.

If the voltage fails the magnet switches drop open; on return of the voltage (the master switch remaining closed), then close automatically in the correct sequence to start and accelerate the motor. For some kinds of service an overload relay is used; this relay is similiar to the series accelerated relay in operation but it is so connected that all but the first magnet switch drops open when an overload occurs. The motor now operates slowly with all the resistance in series with the armature until the overload is removed, after which the open switches close as in starting. The point at which the relay will operate is adjustable by weights on the plunger.

The magnet switch controllers have several applications including the control of direct-current machine tool motors and elevator motors. Figure 21 shows the connections of a push-button controller and Figs. 22 and 23 show, respectively, a Westinghouse full magnetic elevator controller and car switch.

Cutler-Hammer Elevator Controller for Alternating-Current Circuits

THESE controllers are designed for use with slip-ring induction motors operating on either a 2-phase or 3-phase circuit. The complete equipment comprises a controller switchboard, a car switch, one or more limit switches, a slack cable switch, a safety switch and a brake solenoid magnet.

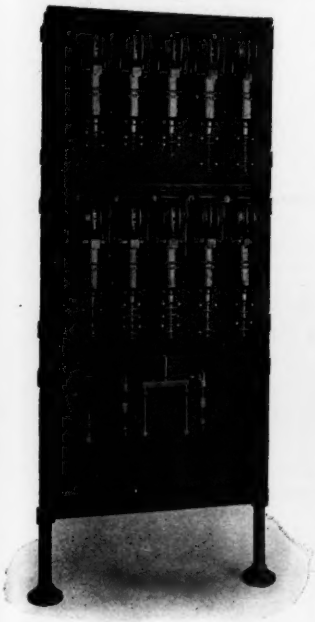


FIG. 22. WESTINGHOUSE FULL MAGNETIC CONTROLLER FOR ELEVATOR SERVICE

FIG. 23. ELEVATOR CAR SWITCH

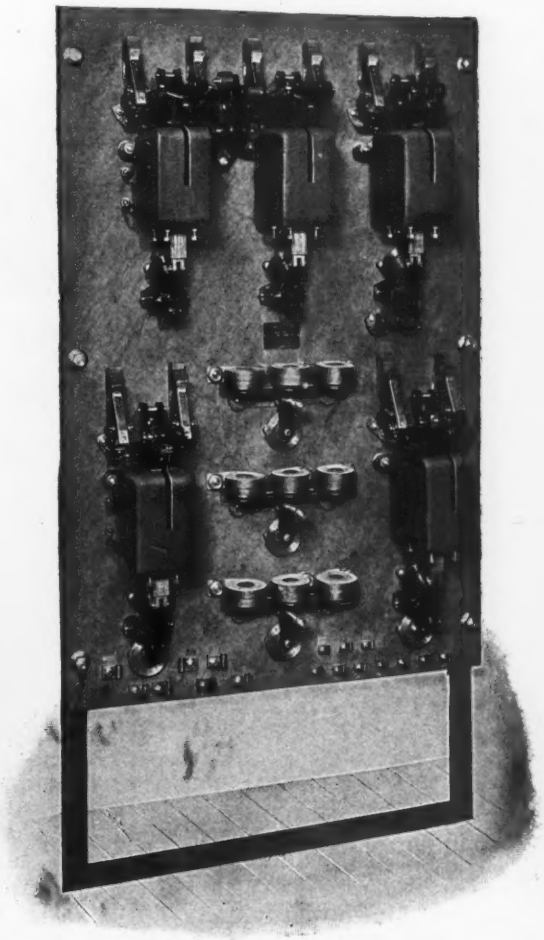


FIG. 24. CUTLER-HAMMER ELEVATOR CONTROLLER FOR ALTERNATING CURRENT SERVICE

The controller switchboard shown in Fig. 24 consists of several marbleized slate panels mounted on an-angle iron frame which serves also as a support for the resistance. Alternating-current solenoid switches mounted on the face of the panel and connected to the resistance, are arranged to perform the following functions: 1. To disconnect the primary

wires from the motor and brake solenoid, in the off position of the controller. 2. To accelerate the motor automatically by cutting the starting resistance out of the rotor circuit step by step (using series relay control) and giving smooth acceleration at all loads. 3. To operate the elevator from the switch-board for test purposes.

It is not possible in elevator service to operate an alternating-current motor at any speed other than its normal r.p.m., nor is it possible to employ with it the dynamic brake used with direct-current motors. This means that the car must be slowed down and stopped by the application of the mechanical brake

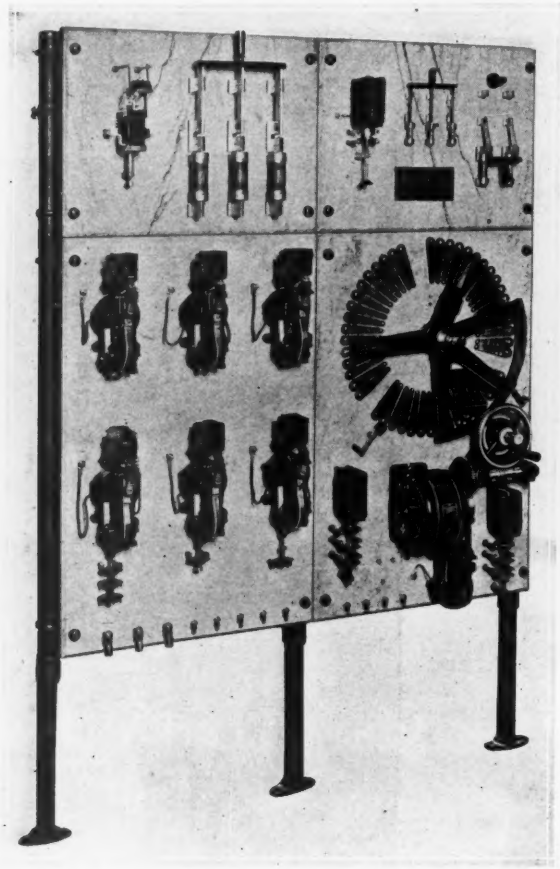


FIG. 26. SPRAGUE AUTOMATIC CONTROLLER FOR USE ON ALTERNATING CURRENT CIRCUITS

alone, and the speed must therefore be one that will permit of this being done with safety and comfort under all the widely varying conditions met with in elevator service. While lacking the variable speed feature of direct-current motors the alternating-current motor is widely used in elevator installations. It can be accelerated from rest to full speed quickly and smoothly and, with all resistance out of circuit, it operates at practically constant speed regardless of the load in the elevator.

Acceleration of the motor is accomplished by a multiple solenoid self-starter with secondary starting resistance. A suitable number of double-pole alternating-current solenoid switches are used, these being so connected as to cut a section of resistance out of each of the 3 phases of the rotor circuit simultaneously, the rate of acceleration being governed automatically by a number of current relays in the rotor circuit. By suitable adjustment of these relays the starting current is limited to a predetermined maximum.

The function of the relay is to lift and open the circuit to the succeeding switch when the starting current rises as each switch in turn is closed, thus preventing the cutting out of the next step of resistance until the motor has properly accelerated and the surge of current incident to the closing of the previous switch has died down. Each of the current relays has 3 coils connected between its switch and the 3 phases of the rotor circuit.

Circuit to the motor is controlled by 3 double-pole switches. Two of these serve as a reverse switch and control 2 of the wires to the motor, while the third switch, used as an additional line switch, controls the other 2 wires on a 4-wire system, or one wire on a 3-wire system. Two of the double-pole switches are always closed in starting the motor, but the open-

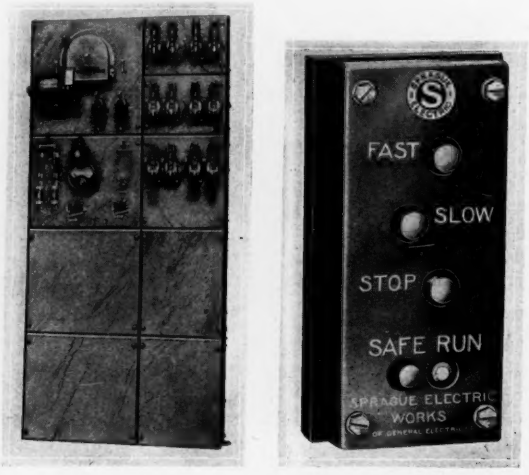


FIG. 25. SPRAGUE FULL AUTOMATIC CONTROLLER FOR USE ON DIRECT CURRENT CIRCUITS
FIG. 27. PUSH-BUTTON STATION USED WITH SPRAGUE FULL AUTOMATIC CONTROL SYSTEMS

ing of either of them is sufficient to bring it to rest. With the car switch in the off position the motor is entirely dead.

The automatic stopping of the car at the 2 limits of elevator travel is usually accomplished by a limit switch of the rotating cam or traveling cam type.

Automatic Push-Button Control System for the Operation of Newspaper Presses.

CONTROL of motors by means of push buttons is entirely automatic. The push button stations are all alike, and located at different points on the press. Each station contains five buttons marked respectively "Fast," "Slow," "Stop," "Safe" and "Run."

With the "Safe" button pressed on one station, all other stations are inoperative and the press cannot be started until the "Run" button on that particular station is closed. An operator who is engaged about the press, plating cylinders, or doing other work involving contact with moving parts of the machinery, presses the nearest "Safe" button and thereby protects himself from injury. If the "Safe" button is pushed while the press is running, further acceleration is prevented, but the press can be slowed down or stopped from any station.

If all the "Run" buttons are closed, pressure on the "Fast" button will start the press, and it will continue to increase in speed while the button is held closed. When the button is released, the press will continue to operate at the speed it has then attained. The press can be operated at as high a speed as it will stand or the controller can be arranged so that a definite maximum cannot be exceeded.

The press may be operated continuously at any speed from the lowest threading speed through the entire range of printing speeds up to the maximum speed desired. For plating the cylinders or threading-in the web, a movement as small as an eighth of an inch can be obtained. The acceleration of the press from threading speed to maximum speed is perfectly uniform without jar or jerk.

By pressing the "Slow" button the press may be slowed down, while running, to any desired speed. When the "Slow" button is released the press will continue to run at the speed it has then attained.

By pushing the "Stop" button the press is brought to a quick stop by means of the dynamic brake. It is stopped so easily that no breaking of the paper can result. On stopping, the controller arm automatically returns to the off position. The press therefore, cannot be started improperly.

The main line, motor, and push-button circuits are brought up to a panel-board on which the various

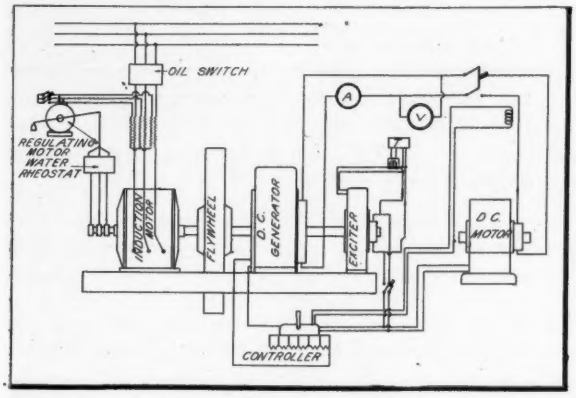


FIG. 28. MOTOR-GENERATOR SET WITH FLYWHEEL USED FOR MINE HOISTING

switches, contactors and relays are mounted. The resistances are contained in an iron frame back of the panel.

The operation of the driving motors is controlled by means of a motor driven master-switch. All motor circuits and armature resistance steps are made and broken on separate contactors provided with powerful blow-out magnets, so that all arcing is reduced to a minimum. The push button circuits operate the small motor which drives the master-switch through two relays.

In the motor-operated controller of the Sprague Electric System, alternating and direct current panels are very similar. It is unnecessary to provide direct current for the control circuits, as with magnet operated systems, having long-pull solenoids. The direct current contactors, relays and pilot motor are merely replaced with alternating current contactors, relays and motor. The operation of the push buttons is exactly the same.

Figures 25, 26 and 27 show respectively a Sprague full automatic controller for use on direct-current circuits, automatic controller for use on alternating current circuits and a push button station.

Special Types of Control for Mine Hoisting

FIGURE 28 shows the connections of a motor-generator set with a flywheel for the operation of mine hoists. This outfit is built by the General Electric Co. and consists of an induction motor with a wound secondary, a direct-current generator, an exciter on one end of the shaft and a flywheel between the motor and generator. The object is to operate the induction motor at constant load, the flywheel taking the starting peak required by the hoisting motor. The speed of the hoisting motor is controlled by the controller shown in the sketch, which varies the resistance of the field circuit of the generator.

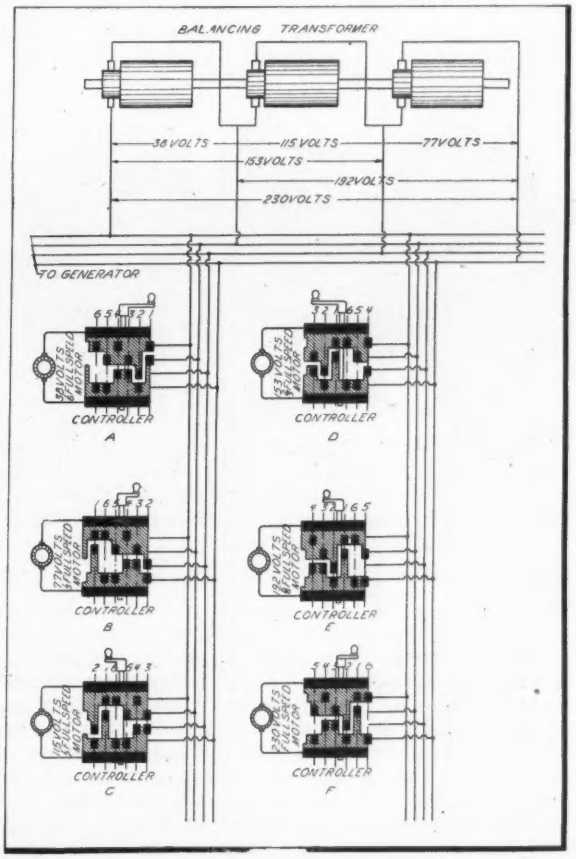


FIG. 29. WIRING CONNECTIONS OF CROCKER-WHEELER MULTIPLE-VOLTAGE SYSTEM

The exciter electromotive force is kept at a constant value, independent of the speed by a Tirill regulator, T. The energy is stored in and withdrawn from the flywheel by varying the slip of the induction motor. This is accomplished by connecting a regulating motor, in the primary circuit of the induction motor so that its parts are balanced against the weight of a water-rheostat mechanism in such a manner that an increase in load increases the resistance of the secondary circuit of the induction motor, thus producing a reduction in speed and allowing the flywheel to help.

When the load decreases, the regulating motor acts in the opposite manner and the speed is increased, thus storing energy in the flywheel. Inspection of the connections will show that the regulating motor

is fed with energy supplied through a series transformer, and that any tendency of the load current to the induction motor to increase will cause a rise in the e.m.f. impressed on the regulating motor and in this way cause an increase in its torque, which is proportional to the square of the impressed e.m.f. An increase in the torque produces an unbalance in the system and operates the rheostat arm so as to increase the resistance of the secondary circuit of the induction motor.

Near synchronism the secondary reactance in the induction motor is small so that the torque is approximately inversely proportional to the secondary resistance, therefore the torque of the induction motor is decreased when the load comes on and the flywheel is forced to take up part of this load. This is accompanied by the necessary drop in speed which again increases the motor torque which is approximately directly proportional to the slip. As soon as the peak load goes off, the motor speeds up, storing energy

FIG. 30. CROCKER-WHEELER 3-UNIT BALANCING TRANSFORMER

in the flywheel and the load current tends to decrease thus causing the resistance of the rheostat to be decreased, and so on. A stop is provided which prevents the operation of the rheostat when the load falls below a certain value to prevent hunting.

Crocker-Wheeler System of Multiple Voltage Control

THIS system of electric motor control for machine tools does not require a specially designed motor. A standard motor from stock is usually supplied, but the system is applicable to any motor of any make, including field weakening motors. Such a system can be installed in any factory or section of a factory where a motor drive is used by simply connecting a 4-wire balancing transformer in the power circuit and wiring through the necessary multiple voltage controllers to the motors, as shown in Fig. 29. Thus a complete multiple-voltage system can be installed without any change in the power house or center of distribution.

In this system the voltage of the generator is subdivided by a 3-unit balancing transformer, shown in Fig. 30 which may be placed in the power house or at any convenient point in the shop. The balancing transformer being automatic in action requires no attention. Six different voltages are supplied to the motor armature. These are called simple speeds. Other speeds are obtained by field weakening and are termed derived speeds. The total number of speeds thus obtained vary from 6 to 23, depending upon the controller used.

The standard voltage for the entire system is 230 for the terminals of each working motor when it is running at the highest simple speed. The 6 different voltages given by the controllers are, 38, 77, 115, 153, 192, and 230. If the working voltage is 240, these voltages would become 40, 80, 120, 160, 200, and 240. The speeds given to the motors by these voltages are approximately proportional to the voltages themselves, the total range being somewhat greater, dropping off a little on the lower point of the range. The ampere capacity and consequent torque of each motor increases above normal when operating on the lowest simple speed. This amounts to 10 per cent at 192 volts, 20 per cent at 153 volts, and 25 per cent at 115 volts and lower. Each set of speeds may be made quite different as a whole by using a larger or smaller motor, because the motor's normal full speed will be different, or by using a motor with a 500-volt armature, cutting all of the speeds in two, or by using a motor otherwise specially wound to give any desired

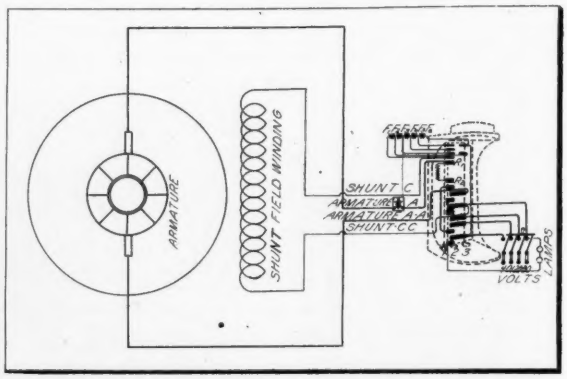


FIG. 31. CONNECTIONS OF A CROCKER-WHEELER MULTIPLE-VOLTAGE CONTROLLER

full speed. Fig 31 shows the complete connections of a multiple-voltage controller.

Repulsion Induction Motors

FIGURES 32 and 33 show the essential features of the Wagner unity power factor single-phase motors. The purpose of the peculiar rotor construction, illustrated in Fig. 33, and of the brush arrangement and connections shown in Fig. 32, is to accentuate at start-

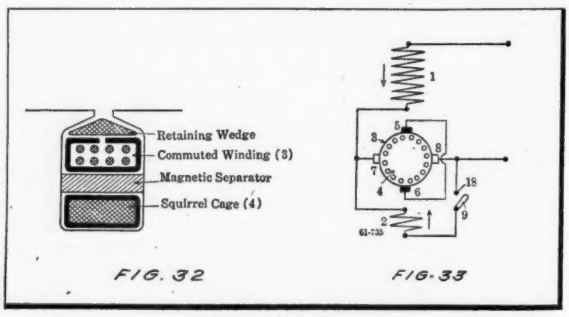


FIG. 32. STATOR WINDINGS OF A WAGNER UNITY POWER FACTOR MOTOR

FIG. 33. ONE SLOT OF ROTOR SHOWING CONSTRUCTION, WAGNER UNITY POWER FACTOR MOTOR

ing the effect of the squirrel cage along the axes 5, 6, of the main stator winding 1, while suppressing it as far as possible along the axes 7, 8, at right angles to 1.

A magnetic separator placed above the squirrel cage winding 4, tends to suppress the effect of that winding along all axes by making the winding less responsive to outside inductive effects, but the influence of the separator is nullified along the axis of

the main stator winding by the presence of the short circuited brushes 5-6, while no means are provided for nullifying its effect along the axes at right angles to that of the main stator winding. Thus the main stator winding 1, will be able to induce heavy currents in both rotor windings because of the short-circuiting brushes in the axes 5-6, and in spite of the magnetic separator while the rotor winding 3, connected in series with 1 will not be able to produce heavy currents in the squirrel cage windings 4, along the axis 7-8, because of the magnetic separator between 3 and 4, which shunts or side-tracks the inducing magnetic flux. The mode of operation may be generally described as follows: At starting, switch 9 of Fig. 26, opens. The commutated winding 3, along the axes 7-8, being connected in series with the main stator winding 1, and across the mains, the winding 1 induces a large current in the rotor winding 3 and 4, along the axes 5-6, and the winding 3 produces a large flux along the axes 7-8. The rotor current in the main axis co-acting with the flux threading the rotor along the auxiliary axis yields the greater part of the starting torque. As the motor starts up the squirrel cage gradually assumes those functions which it performs in the ordinary single-phase squirrel cage motor, developing a magnetic field of its own along the axis 7, 8, and a correspondingly powerful torque which increases very rapidly as synchronism is approached and falls suddenly to zero at or near actual synchronism.

It is known that magnetizing currents circulating in the bars of a squirrel cage rotor of a single-phase motor have at synchronism, double the frequency of the stator currents. The fluxes they produce must therefore also be of double frequency. Now the magnetic separator is made of solid steel, and while this separator forms a sufficiently effective shunt for the fluxes of line frequency induced from the stator it is quite ineffective as a shunt for the double frequency fluxes produced by the rotor. As far as the squirrel cage is concerned, the effect of this magnetic separator diminishes with increasing speed, and at synchronism the machine operates practically in the same manner as if the magnetic separator did not exist at all.

(To be continued.)

PRESERVATIVE TREATMENT FOR STORAGE-BATTERY TANKS

A SIMPLE method of rendering wood capable of resiting the action of acids and other chemicals, especially adapted to the treatment of the woodwork of chemical laboratories and storage-battery tanks, is described in a recent issue of Elettricista. The treatment comprises the successive application of two solutions followed by the application of soap. The first solution is prepared by dissolving one part by weight of aniline hydrochlorate and one part of ammonium hydrochlorate in six parts of water; the second, by dissolving two parts by weight of copper sulphate and one part of potassium chlorate in twelve parts of water.

The wood to be treated is carefully cleaned and scraped or planed to a smooth surface. The first solution is then applied and some time is allowed for impregnation, after which the wood is thoroughly dried in the air. A similar treatment follows with the second solution, and the two operations are repeated 4 times. At the end of this stage the wood has a greenish tinge, and the surface is covered with small crystals deposited from the solutions. Powdered soap is then spread on the wood, and the surface is thoroughly scrubbed with a plentiful supply of water. The treatment is concluded, after the wood is throughly dried, by a hard rub with a cloth soaked with linseed oil.

The final surface finish is a brilliant black. In addition to making the wood practically indestructible by chemicals, the treatment leaves it practically incombustible. Its very high power of resistance to the action of acids and alkalies is due largely to the soap, which, having entered the pores, renders the wood absolutely impermeable to liquids.

GROUNDED WINDINGS THROUGH CONDENSED STEAM

THE machine in question was a 300 hp. slip ring induction motor, and was operating in a factory where the use of steam was required in several of the manufacturing processes, and where the atmosphere in which the motor had to work was consequently pretty well charged with moisture, owing to the condensation of considerable quantities of escaping steam. At various intervals inspection of the core and windings of the motor would reveal the fact that they were covered with an appreciable coating of damp, owing to the condensation of steam on them. In conditions such as these, a coil winding in stator will probably not be found to suffer from the presence of this dampness; but in the case of bar wound machines with unprotected bondings at the ends of the bars, the damp will collect and cause a path for leakage. If there is any weak spot in the winding, this may then cause a short-circuit of so many turns by grounding the winding at two points.

In the particular case under notice, there was considerable leakage from the bondings on the stator conductors along the damp to the core, and this caused the windings to become grounded at some other point by partially grounding another part of the circuit through the damp. The result was that a short-circuit occurred due to these two points becoming grounded. It was perhaps additionally unfortunate that the actual grounds should occur in the slots carrying the beginning coils of two different phases; so that in effect this amount to a dead short-circuit across two of the incoming lines, and the system (which was comparatively a small one) was in consequence shut down. The teeth of the stator core where these two grounds occurred were badly burned.—General Electric Review.

CORROSION TESTS OF ALLOYS are commented upon in the 1910 annual report of the Board of Water Supply of New York City. In 1908 specimens of 6 representative bronzes were partially embedded in concrete cubes and placed in Esopus Creek. In 1910, after an exposure of 2 years 2 months they were examined and weighed. The average thickness of metal lost from the surface of the most corrosible specimen was 0.000,248 in. and the average loss from all specimens was 0.000,136 in. The tests are being continued in connection with the work of constructing the Catskill aqueduct.—Engineering Record.

FIRE LOSSES AND the cost of fire prevention in the United States amount annually to $450,000,000, or more than the total American production of gold, silver, copper and petroleum in a year.

KEEPING POWER PLANT RECORDS

Why It Should be Done; Use of Records for the Plant and the Engineer

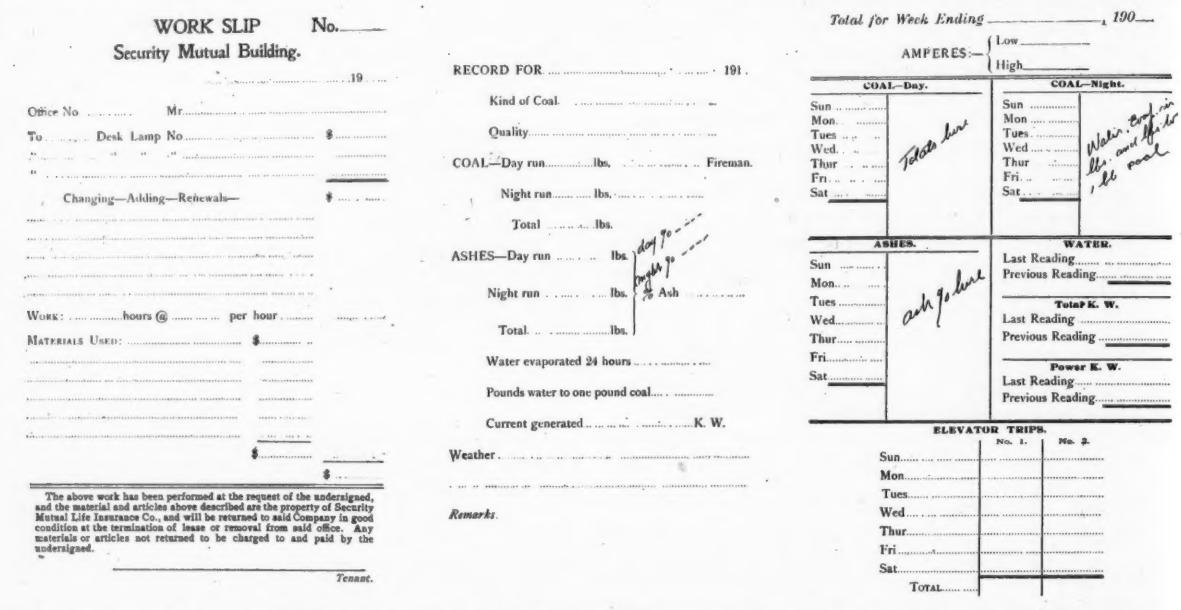
By Asa P. Hyde

DAILY checking of the operations of the plant is, I believe, absolutely necessary if you expect to obtain good results, and I think that engineers reasonably can be expected to do so, and to have figures for comparison both for his own and his employer's use, especially his own.

The designing of the forms and adapting them to the particular job is no great task, although it will require study and experimenting to get them, but in the end it will pay, and well.

of which were suited to our case, and by several I was told to "keep out of it," it would take too much time, if asked, to hand in a report of the fuel used, labor and general expenses, as oils, waste, tools, supplies, etc., and let them do the rest if they wanted it.

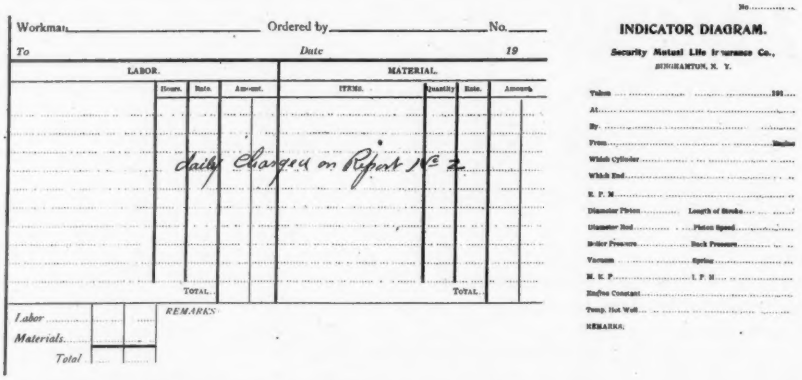
This did not sound good to me, even coming as it did from good sources. What would I know of the detail and general results under such a system? I might be told it was either good or bad as they liked and I would be none the wiser of it. It reminded me



ANY ADDITION WANTED IS FURNISHED FREE BUT EACH TENANT RECEIVING SUCH WORK SIGNS THIS SLIP ONE BEING FILED WITH THE LEASE AT THE PLANT THIS STOPS ONE LEAK IF TENANTS TOOK BY MISTAKE LAMPS

DAILY RECORD OF RESULTS FILED IN A GLASS CASE WITH RECORDING STEAM GUAGE CHART IN BOILER ROOM FOR FIREMENS AND COAL DEALERS INSPECTION.

ON THIS I FIGURE MY PERCENTAGE WEEKLY AND ENTER ON SHEET NO 3



ANY AND ALL WORK RECORDED WITH MATERIALS USED. I HAVE THE WORK OF TWO BLOCKS ASIDE FROM JANITORS ALL IS REPRESENTED HERE THEN ENTERED ON SHEET NO 2

WORKMAN'S ORDER AND REPORT BLANKS, AND MISCELLANEOUS FORMS

In my case it took a good many nights and Sunday's work to get what I wanted. When we first started our plant I commenced by writing to several engineers of plants, consulting engineers and manufacturers, but found only a few who had forms, none

forcibly of my personal experiences several years ago when I was interested in a manufacturing business as 1 of 3 partners and as superintendent where we had several different branches to be cared for. I then had a system from which I could tell at any time which,

if any, part was dragging, or not doing its share. It enabled me quickly to detect it and make it do its part. I was not obliged to carry any part that was not paying. From my store books I could buy my

DAILY

COAL TICKET.

No._____ 191___

6. A. M. to 6. P. M.		6 P. M. to 6 A. M.	
LBS. COAL.	LBS. ASHES.	LBS COAL.	LBS. ASHES

KIND OF COAL. KIND OF COAL.

Fireman. Fireman.

Coal Used_____lbs.
Ashes Made_____ "
% Ashes_____ "
Water Used_____Gals.
" " _____lbs.
" _____lbs. to 1 lb. Coal.
Boiler Water Test: Good. Med. Low.

FORM USED IN ACCOUNTING FOR COAL IN THE BOILER ROOM

supplies, take my inventory, knowing at any time what was on hand, or where it had gone.

So now, when the opportunity came to me as an engineer, I could see no good reason for not operating

Ash Ticket. _____ 190

CANS FILLED.	FIREMAN.	CANS TAKEN.	CARTMAN.
	THE DIFFERENCE BETWEEN CANS FILLED AND TAKEN ARE CANS OF WASTE FROM THE BLOCK AND CHARGED AGAINST IT.		

FORM FOR ASH TICKET

the plant in the same businesslike way, or the same as any merchant or business man would naturally ex-

FIREMENS' REPORT.

Quality Coal, Day, Describe ..
" " Night "
If Clinker, Day "
" Night "
If Fires Build up, Day " Night
Shook or Cut Fires, Day Times. Night Times.
Steam drop, Day, Why Night, Why
Draft, Day Good. Med. Poor. Night Good. Med. Poor.
Load, Day Heavy Med. Light. Night Heavy. Med. Light.
Live Steam Used, Day hrs. Night hrs. Weather
Condition of Apparatus and Wants

REPORT FORM FOR FIREMEN

pect to conduct his business, that is if he expected success.

So contrary to the advise "let them do it" I went after the record system, and although it does take up some time, I am positive it has paid well. We all feel the better for it and are interested in it. Like watching the daily weather reports, we watch for the daily reports which are posted where all can see

No._____ METER READING. _____ 191

Power _____

Total

K. W. Hour Consumption_____ Rate___cts. Total $_____

THIS IS ELEVATOR POWER METER
BY COUNTING TRIPS AS DONE BY COUNTER ON EACH CAR AND CHARGING CURRENT WE KNOW WHAT EACH TRIP COSTS.

No._____ METER READING. _____, 191

Customer_____

Total

K. W. Hour Consumption_____ Rate___cts. Total $_____

CUSTOMERS IN BLOCK OUTSIDE PAY ON FOR POWER RECORDED BY METER

No._____ METER READING. _____, 191___

Total_____

Total

K. W. Hour Consumption_____ Rate___cts. Total $_____

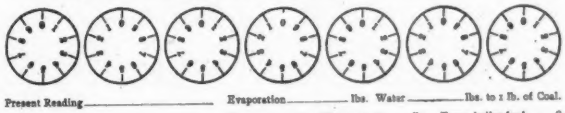
ALL CURRENT GENERATED RECORDED HERE

WATER METER READING. _____, 190___

Present Reading_____
Previous Reading_____ _____lbs. _____lbs. to 1 lb. coal.
Consumption_____

CITY WATER METER READING

WATER METER READING. _____, 191___



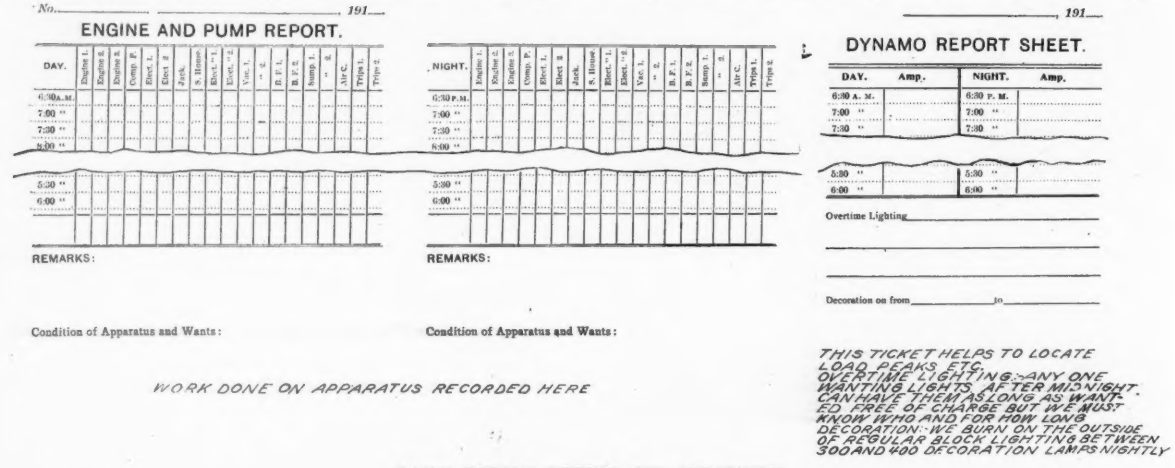
Present Reading_____ Evaporation_____ lbs. Water _____lbs. to 1 lb. of Coal.
Previous Reading_____ Vacuum ___ in. Bk. pressure ___ lbs. Temp. boiler feed ___°
Consumption_____ Temp. Hot Water for Block °
Carnegie Library Bk. Pressure_____ Live Steam, Block { Day ___ hrs. Night ___ "
" " Live Steam { Day ___ hrs. Night ___ "

EVAPORATION METER
WE CARRY THE CARNEGIE LIBRARY LIGHT HEAT AND HOT WATER

FORMS FOR RECORDING METER READINGS

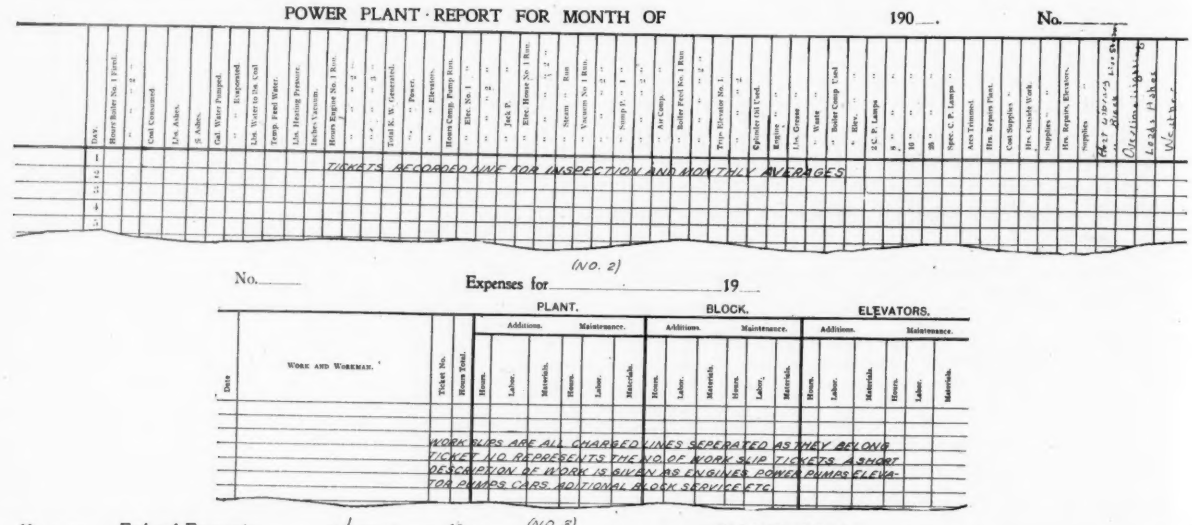
them, and we are all daily trying to improve on them. It is possible we could have reached equally as good results without them, but I greatly doubt it, and even if we had we would have had no figures to go by, or check back on.

It is satisfactory many times if you have a seemingly large coal consumption, or apparently something wrong, to be able to refer back to records for from 1 day, to 1, 2 or 3 years as you like to compare today's results with 1 year ago today, to see how it was then. To compare our coal, ash and evaporation with the output, the heating, elevator service and weather, one going to properly check the other.


No. 191
ENGINE AND PUMP REPORT.
DAY.
NIGHT.
REMARKS:
REMARKS:
Condition of Apparatus and Wants:
Condition of Apparatus and Wants:
WORK DONE ON APPARATUS RECORDED HERE
191
DYNAMO REPORT SHEET.
DAY. Amp.
NIGHT. Amp.
Overtime Lighting
Decoration on from to
THIS TICKET HELPS TO LOCATE LOAD PEAKS ETC. OVERTIME LIGHTING:-ANY ONE WANTING LIGHTS AFTER MIDNIGHT. CAN HAVE THEM AS LONG AS WANTED FREE OF CHARGE BUT WE MUST KNOW WHO AND FOR HOW LONG DECORATION:-WE BURN ON THE OUTSIDE OF REGULAR BLOCK LIGHTING BETWEEN 300 AND 400 DECORATION LAMPS NIGHTLY

DAILY REPORT SHEETS FOR APPARATUS

at times unfair competition. So far we have won out, all pulling together for one object—a good report. Many times when questioned we have handed in our records and figures for a week, a month or a year, as


(NO. 1)
POWER PLANT REPORT FOR MONTH OF 190 . No.
TICKETS ACCORDED LINE FOR INSPECTION AND MONTHLY AVERAGES
(NO. 2)
No. Expenses for 19
PLANT. BLOCK. ELEVATORS.
Additions. Maintenance.
WORK AND WORKMAN.
WORK SLIPS ARE ALL CHARGED LINES SEPERATED AS THEY BELONG TICKET NO REPRESENTS THE NO OF WORK SLIP TICKETS A SHORT DESCRIPTION OF WORK IS GIVEN AS ENGINES POWER PUMPS ELEVATOR PUMPS CARS ADDITIONAL BLOCK SERVICE ETC
No. Fuel and Evaporation November 19
(NO 3)
Switch Board Load.

MONTHLY REPORT SHEETS

The record system if followed will help to check in time many a small leak that might get to be a bad wanted. These could not be gone back on or questioned. It is a ready means of checking leaks or

(NO. 4)

ON THIS SLIP WE SEPERATE EACH ARTICLE BUT IN THE END THE PLANT HAS TO STAND FOR IT ALL

No. 11 **POWER PLANT EXPENSE SHEET** Jan. 1910

BOILERS H. P. STEAM AND EXHAUST LINES.

Coal Lbs. $ per Ton.
Carting Ashes Loads per Load.
Boiler Compound Lbs. per Lb. Kind.
City Water "Plant only."
Hose, Gaskets, Tools.
Repairs Boilers, Arches, Lines.
Water Glasses, Gaskets.
Feed Water Heater,
Boiler Feed Pumps,
Extras,

ENGINES AND GENERATORS.

Repairs Engines, Repairs Generators,
Packing used, Lamps Plant,
Oils and Greases, Switch Board,
Cotton Waste, Extras,
Repair Traps,
Extras,

HOUSE PUMPS AND LINES.

Labor Men $ Less Hours Elevators $ Plant.
Packing Steam, Water,
Valves,
Repairs Pumps,
" Motors,
Tanks and Lines,
Extras,

ELEVATORS AND ALL APPARATUS.

Motors and Belts, Cars,
Controlls and Lines, " Fibres,
Extras, " Cables,
Waste, Oils, Grease, Etc.,
Triplex Pumps, Plunger Packings,
" " Packings, Leather Valves,
" " Valves, Tank Compound,
" " Extras, Extras,

Compound Pump,
" " Packings, Air Compressor,
" " Valves,
" " Extras,

GENERAL ACCOUNTS.

Work Total, Hours per Hour
Soaps Hand, Soap Common,
Tile Cleaner, Laundry,
Mops, Polishes, Etc.,
Paints and Brushes, Printing,
General Supplies,
Shop Tools,
Motors Plant, "all"
Fans " "
Extras,

Outside Work 26½ Hours 40 per Hour - - - - $ 10.60
Work 4½ Hours on Elevators 4.0 per Hour - 1.80
12.40
Elevator Supplies - 8.68
21.08
All Other Charges Foreign to Plant as checked ✓ - - - -
Foreign Charges - $ 21.08

✓ 434 Contra Cr.
✓ 1458 Return
1892

Maintenance 660.30

Current Generated 32200 K. W. Hrs. for Month Cost 2.05/100 per K. W. Hour and Maintain Entire Apparatus at $660.30
" " Less Foreign Charges (21.08) 1.92/100 per K. W. Hour
" " " " and $ 10000 1892 Cr. for heating Block, Bath, Hot water, Barber, Steam Pumps, Etc. 1.57/100 per K. W. Hour
" " @ .04 per K. W. Selling Price $ 1,288.00 Total Expenses $ PROFIT COST $ 627.70

Carnegie Library

Elevators Made 21586 Trips and Cost 4/100 per Trip for Current.

MONTHLY POWER PLANT EXPENSE SHEET

troubles; puts all hands on their mettle to do their best, and is I think a coming part of up-to-date engineering.

I believe that our employers have a right to ask this of us, and it means as much as our running experience license or character. They have a right to require us to produce results, and figures to back it. These all certainly help to prove our worth to them.

To not keep records, to me would seem like being sent to the bank with a large bill for change, we to take whatever is given us without counting it over. It may be right. If not how do we know. Can we makes the boss see that we did all we should, or whose fault it is that the results are not better? So in the plant he is trusting us with a large amount of change. We should have an account of the exact change.

There is another thing that we are cranks on here. that is system. We have a time for our work and so far as possible or practical, carry it out. Have a place for all stock and tools. We each know where

COMPARISON OF 1907-1908-1909
FOR THREE MONTHS EACH OCT-NOV-DEC.

DATES	COAL	LOAD IN KW HR	ELEVATOR TRIPS	
1907				USED 25246 LB.
OCT.	221269	23890	21947	MORE COAL 1909
NOV.	223371	21010	21127	THAN IN 1908 AND
DEC.	225569	25530	21641	GENERATED 13350 K.W.
TOTALS.	670809	70430	64715	HR. MORE CURRENT
1908				INCREASE IN FUEL
OCT	210185	29150	22045	USED 1909 OVER 1908
NOV.	214731	30000	19997	3 9/10 %
DEC.	222980	33090	21193	INCREASE IN K W.
TOTALS	647896	92240	63235	OUTPUT 14%
1909				INCREASE IN FUEL
OCT	212018	33910	21385	USED 1909 OVER 1907
NOV.	222094	34910	21139	9/10%
DEC.	239033	36770	22614	INCREASE IN K.W.
TOTALS	673145	105590	65138	OUTPUT 33%

ADDITIONAL LOAD FROM PHELPS BUILDING SEPT. 18 1908.
CARNEGIE LIBRARY TAKEN ON OCT. 20-1909 CONSISTING OF LIGHTING, HEATING AND HOT WATER SERVICE.
PLANT IS IN AS GOOD OR BETTER CONDITION THAN THE DAY STARTED, OVER 5 YEARS CONTINUOUS SERVICE AND BEING CARED FOR BY THE SAME AMOUNT OF HELP

COMPARISON OF COAL CONSUMPTION AND POWER FOR SAME PERIOD IN DIFFERENT YEARS

it is and use it. If not there is usually something doing. We have to make our work count, for there are but 4 of us to run the entire plant of upward of 400 hp. and 350 engine and generator hp., with many motors, pumps, 3 elevators, the lighting through the block, with the heating, plumbing, and all other apparatus of a 10 story office building. We run continuously the year around. The plant is now 8 yr. old., daily charge is on the records against each piece of apparatus, its upkeep. It is a great help to know what each costs and earns. It pays to time the different jobs, both the new and the repairs; see what they and the daily work costs, not for once, but several times, or until you get an average. Then arrange a table of it for reference. It will help you to know and judge of changes, new work or maintenance charges, and may place you in better standing with the boss some time if asked.

You Mr. Engineer may say you have not the necessary time, but I'll wager many spend enough time reading the daily and Sunday papers to go a long way one record keeping. Try it and if the boss sees you are trying he will be more likely to help you out than if you are daily seen doing the other, or spending time uselessly.

The sloppy, shiftless starter and stopper of an engine is not wanted these days, although some do put up with them for awhile. It is becoming a case of study and hustle to keep up with the times. Some tell us there is "room at the top," there is, but it is up to us to make the place for ourselves if we want one. No one will hoist us up there without an effort on our part. If we don't keep some records, study our work, our apparatus, and our jobs, how can we reasonably expect to compete with central station service or those higher up. There is no use knocking them. They are all doing business, and in a business like way. We too must or get out, or be put out. It is up to us not them.

Engineering is a profession and I am proud of it. There is one way to make ourselves more respected as members of it, and that is—keep a set of records and be prepared to meet any one at any time with figures, either in your office or theirs. Try it out and see, it will help you out in your work and be one means of gaining knowledge and advancement.

HOW TO MEASURE A RIVER

Simple Method Described for Determining the Volume of Any Stream

THE United States Geological Survey frequently receives letters inquiring for some simple method of determining the approximate flow of streams or small rivers.

To ascertain the velocity of the stream choose a place where the channel is straight for 100 to 200 ft. and has a nearly constant width and depth; lay off on the bank a line 50 or 100 ft. in length, marking each end; then allow small chips to float down the stream, by one of the methods described below, noting the time required for these to traverse the distance laid off on the bank. The surface velocity in feet per second is obtained by dividing the distance in feet passed over by the float by the time in seconds it takes the float to travel this distance. The average of several such determinations will give the mean surface velocity of the stream. This result multiplied by the coefficient 0.8 gives very nearly the mean velocity of the stream.

To obtain the area of the cross section of the stream, stretch a tape from shore to shore and take the depth of the stream at intervals of 2 to 5 ft. The average of these depths may be assumed as the mean depth of the stream. This average multiplied by the total width will give the area of the cross section of the stream in square feet.

The discharge is found by multiplying this cross-section area by the mean velocity, as obtained by the float measurements, the result giving the discharge in second-feet, or in other words, the number of cubic feet flowing past the point of measurement each second.

In determining the velocity for small streams and when only approximate results are desired, the float is placed in the center of the stream only. For larger streams and when greater accuracy is desired a tape is streached across the stream and the distance between the banks is divided into a number of equal spaces or sections. Floats are then allowed to drift down the stream as near as possible in the center of each of these spaces, the same number of floats being used for each section. The mean surface velocity is then assumed to be the mean of the surface velocities obtained for the several sections. For each float the distance of its starting point from the right bank is recorded as indicated.

HALF-BAKED JUDGMENT and immature advice will ruin any plant.

CORRECTING VALVE SETTING

Study of Indicator Cards From Various High Class Engines With Many Kinds of Valve Gears, Running at Different Piston Speeds

By C. R. McGahey

WE will present these cards as they were found, with changes for the better running of the engine; the cards Nos. 1 and 2 are from a high-speed engine using a single valve of the flat faced telescopic construction. The features of these cards are peculiar and very marked. The admission is quite late and irregular, the compression sharp and abrupt

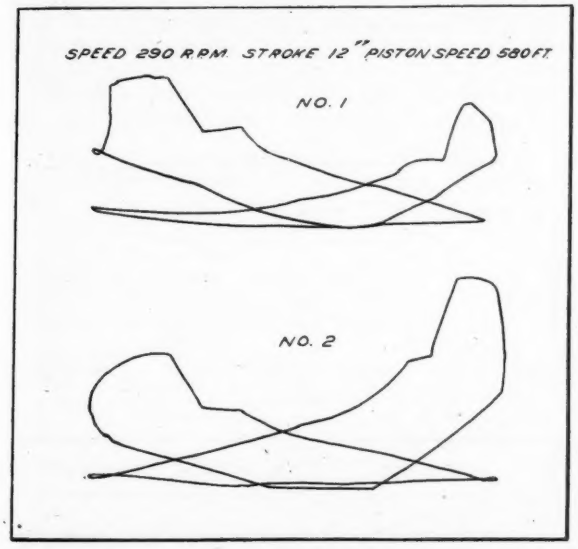


FIG. I. CARDS FROM A HIGH-SPEED ENGINE USING A SINGLE VALVE

pointing out the fact that the piston is tight and not leaking, while the compression is excessive and admission late.

In order to better the condition of the engine it was necessary to move the valve draining mechanism ahead. The engine having an outside connected crank with the governor and eccentric crank on the outside

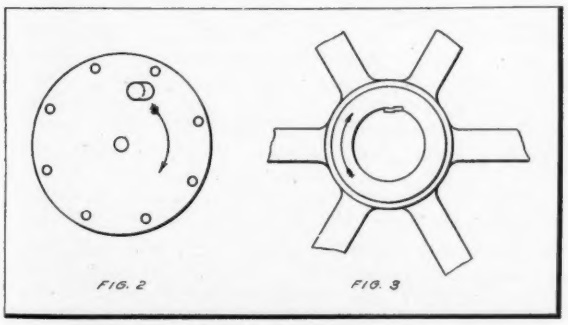


FIG. 2. MOVING CRANKPIN HEAD
FIG. 3. OFF-SET KEY FOR FLYWHEEL

and of such construction that neither the wheel nor the crank could be moved as a whole, we had to move the small crankpin ahead as shown in sketch Fig. 2, and by taking off 1/16 in. on the exhaust side of the valve to lower the compression, which is made more excessive by moving the pin ahead, we got a nice card.

The cards were balanced by setting the rocker arm in its proper position. This valve has a considerable movement compared with the movement of the piston which is marked in the cutoff and is a good feature in a valve. We found this card on several of the same make of engines and it would appear that the designer does not believe in sharply defined admission

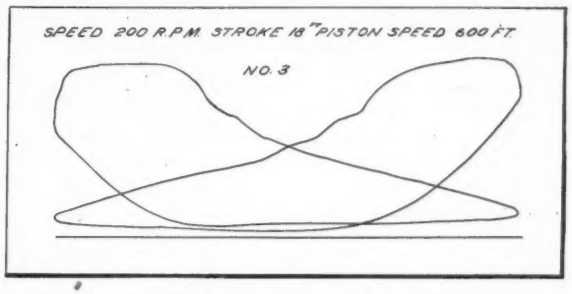


FIG. 4. FROM ENGINE WITH GIDDINGS GOVERNOR

lines, at various loads, as these 2 cards were taken from the same cylinder points that the movement of the valve in relation to the crosshead is excessive which is a good fault but should not be carried to the extreme.

The card No. 3 comes from an automatic high-speed engine using the Giddings form of valve. While this card has somewhat the same characteristics as the first presented, the points are not so abrupt, the

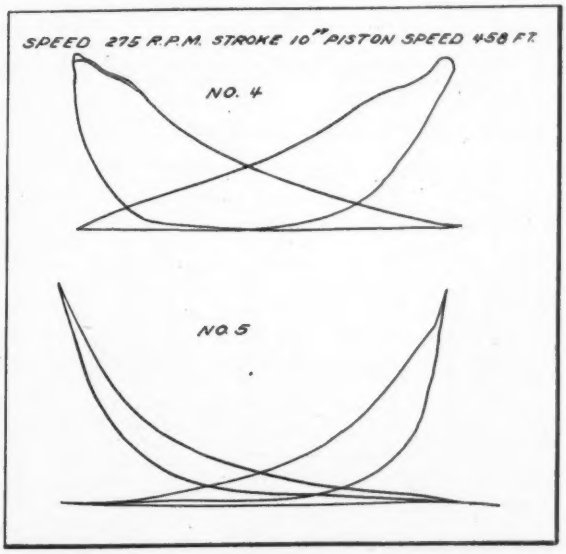


FIG. 5. CARDS FROM HIGH-SPEED 4-VALVE ENGINE

admission is late, steam line is comparatively good. The expansion and release are both good for a single valve, while our admission is quite late but not so much so as cards Nos. 1 and 2 as the piston speed is somewhat greater than for the first 2 cards.

This was another case where the eccentric could not be moved around on the shaft owing to its fixed

position on the flywheel; so in this case we made an off-set key as shown in cut Fig. 3 and relieved the valve 1/32 in. on the exhaust or compression side holding our compression as shown on card No. 3.

Cards Nos. 4 and 5 come from a small high-speed 4-valve engine having all 4 valves connected to a shifting eccentric. The engine was shifted from light to heavy loads as shown and the distribution is good for a small engine; the angularity of the connecting rod is not so pointed in these cards as in those of larger engines.

No change in valve adjustment was made as the engine showed a remarkable fuel consumption, lower than that reached by some twice the size, so this would point to this setting of the valves as good for such

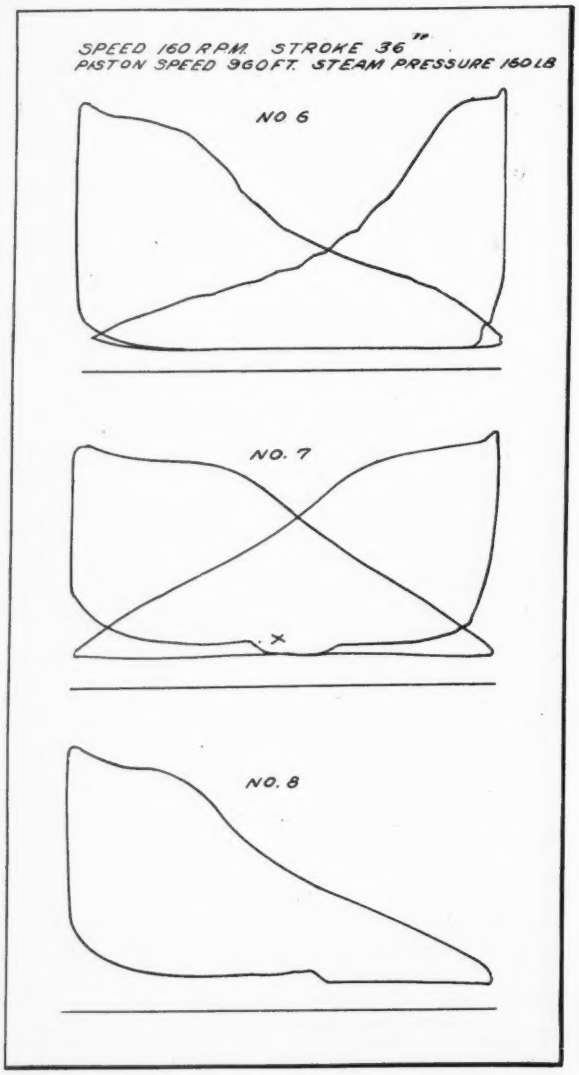


FIG. 6. CARDS FROM ENGINE WITH SWEET ADMISSION AND CORLISS EXHAUST VALVES

running conditions. The compression and release are well defined, the compression, however, is somewhat in excess on the head end. The movement of the indicator drum was considerable compared with the stroke; if we could have our drum to move the same in proportion to the movement of our cross head, our comparisons would be more interesting as the characteristics would be the more pointed.

The cards Nos. 6, 7 and 8 come from an engine with a high piston speed having a 4 valve cylinder. The steam valve was a modification of the well-known Sweet valve. The exhaust valves were of the Corliss type. The steam or admission valve was driven by a shifting eccentric. Card No. 6 is not quite equally balanced, this was made equal and the card brought right by moving the inclined rocker ahead 5/8 in.

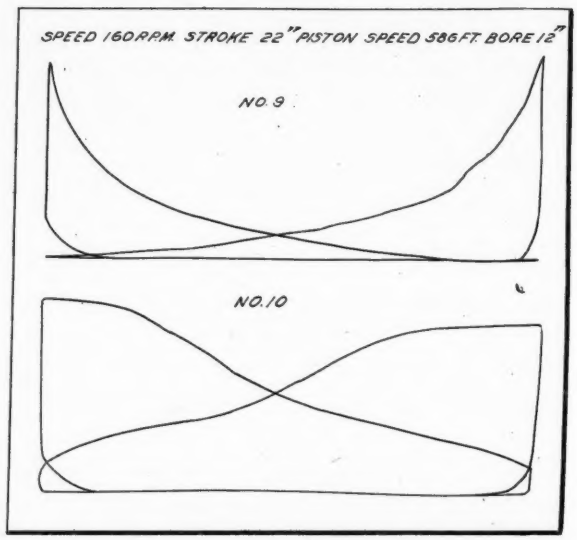


FIG. 7. CARDS FROM ENGINE CONTROLLED BY SHIFTING ECCENTRIC

These cards show excellent admission, this point is helped out by having a multiporated valve for the admission; the steam line falls away, due to a drop in the steam pressure, the feed or steam main was once used for a smaller engine and was later replaced with a larger line. The characteristics of these cards are good, the expansion line and release are good. Card No. 6 shows good condition with the exceptions pointed out as this is a much higher piston speed than the others shown.

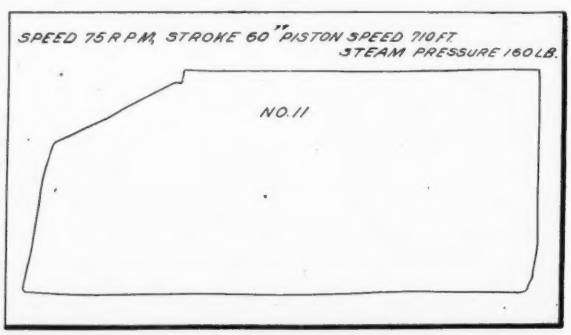


FIG 8. PECULIAR CARD FROM RIVER STEAMER ENGINE

This engine is compound condensing, and cards shown are from the high-pressure side card, No. 7 is from the same cylinder with a different spring working the engine under heavy load and a peculiar point is developed here that is not often met with in indicator practice. The jump in the exhaust line comes from the clearing of the valve on the low-pressure side and

the receiver being too small causes this pressure to rise. The admission valve closing on the low-pressure side at this time raises the receiver pressure, this is clearly shown in card No. 8. A new steam main was run to this engine and the steam line on the card ran horizontal.

Cards Nos. 9 and 10 were taken from a 4-valve engine, the admission was controlled by a shifting eccentric and the exhaust valves operated from a fixed eccentric. These cards show the extreme loads and remarkable characteristics for such a valve gear; while the load was not quite balanced when found, compression was excessive on head end and the admission a little quick, these were corrected. This is a good economical engine, the piston speed was well up for the bore, the admission and compression have nice features for a fixed 4-valve engine, the light load card being almost like that of a trip gear Corliss. The compression appears late but as long as the engine runs quietly and economically, I would say that it

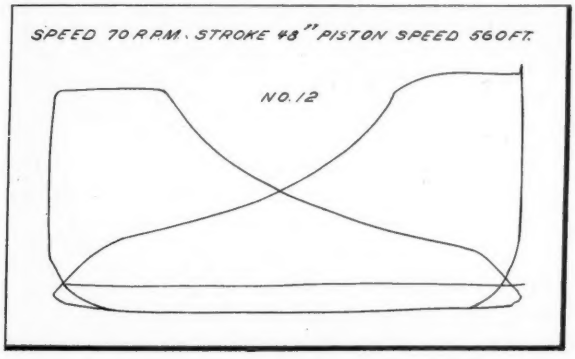


FIG. 9. CARD FROM A 40-YR. OLD CORLISS

is right; the slight movement of the exhaust valve and one admission valve brought this engine in perfect condition.

Card No. 11 I am presenting to the readers as one of a rare kind not usually found in our indicator practice and from this stand point I hope it will prove of interest; this is from a river steamer having the valve driven by a Hall valve gear. A piston valve was used on the engine, you will note the piston speed was well up; all movements with this gear are quick and sharp, the admission and steam line almost perfect, cutoff well defined, the expansion and release sharp and well defined, the compression was somewhat late. This gear being such that the engine is reversed on the one eccentric, we found it necessary to spread the valve heads apart which corrected this fault as the engine would pound some on heavy loads. These engines undergo some hard work.

Card No. 12 was taken from a G. H. Corliss engine that had been running about 40 yr., it was not quite balanced and this we remedied by moving our rocker back making a perfect card. This shows the remarkable condition of this engine after a long run; however, the valve gear was always in the condition as shown by card No. 12. This was no big fault but only points out the fact that it is well for our engineers to indicate their engines as the conditions may be worse than they realize. The erecting man left this engine in this condition, I was informed by one of the old time engineers that had been with the engine since its installation, after long years of use, however, this card shows all points of beauty and the remarkable condition of this engine after many years running.

We have presented the foregoing cards with their changes which come from many engines having different valve gears and running under different conditions and varying speeds.

FROM THE DAY'S WORK

By N. W. Duell

At his desk sat the Chief, cutting out the rules and tables from his Practical Engineer with a pair of tin snips and punching the holes with a belt punch to put them in his new loose leaf holder.

In walked an old timer, and after handing to the Chief the mate to the stogie on which he was puffing, said: "We had a circus when we set up that old non-contained engine; well sir, we got the wheel on and the crank shaft in and found when connecting up that we had left the eccentric cam off. We took out the shaft, put on the cam, put on the yoke, and found the cam was on backwards. Out she came again, and after turning the cam around and replacing the shaft and everything ready, we discovered we had left off the governor drive pulley. That was enough, and the next time we managed to get everything on when putting her back."

The Chief turned to the old timer and said: "Some folks have queer ideas about power plant apparatus; and now there's that twin feed engine under the mill; it has only one eccentric to each cylinder, but I heard a man argue that one engine pulled the carriage one way and the other engine pulled it the other way. Now the fact of it is that the engine has 2 piston valves, and when the engine runs one way it takes steam at the inside edge and exhausts at the end of the valve, and when reversed, takes and exhausts steam vice-versa."

"Yes, and queer ideas on supplies and work too," said the O. T.

"The old man came in one day when I was packing the piston rod with big and cheap packing, and he said, 'Why are you monkeying at that now again?' I said, 'Oh, nothing, just a getting ready for another blowout.'"

Just then, Jack the pipe fitter, who was connecting up the 14,000-gal. supply tank to the fire pump came in and exploded, "Say Chief, how do you want that tank piped up, in the top or bottom?"

"Why, the bottom of course. Why?"

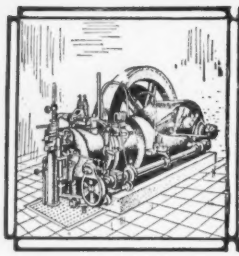
"Well, Raffles, the bookkeeper was out there a while ago, and said they had figured it up in the office and found that there was over 5 tons to pump against when the tank was about full, and that you couldn't fill it."

"Well, you tell Raffles to multiply 0.434 by 30, the height in feet of the column of water, and I don't care if the tank is as big as Puget Sound."

Jack took a chew of Peerless plug, rolled it over twice, went out and looked at the Sound and went back to work.

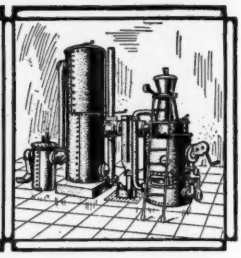
GLASS WAS HALF FULL

A CERTAIN night watchman had among his duties, keeping a fire under a steam shovel boiler. One day the boiler was emptied, washed, and left empty with all hand hole plates out. The next morning the engineer found a smart fire going under his empty boiler. Finding the watchman he asked, "Jake, did you build a fire under the boiler?" "Sure." "Was there any water in it?" "Sure; glass was over half full." C. S.



Gas Power Apparatus

Producers, Engines and Industrial Applications



DISCIPLINE FOR THE GAS ENGINE

Points to be Watched in Keeping It in Order

By C. H. Bromley

IT is an oft asserted fact that steam engineers are frequently confronted with the handling of gas engines whose theory and operation many are quite ignorant of. This lack of understanding of an engine of such great import and possibilities as the internal combustion engine is not due to a disinterested or lethargic state of mind so much as it is due to a preconceived dislike, or better, prejudice against anything that savors of internal combustion.

The steam engineer is too prone to pooh-pooh anything outside of steam, and the merits of the internal combustion engine do not appreciably enter into his consciousness until he has had to do with this type of engine. For the first 2 weeks of his new duties the ex-steam man is fully convinced of the correctness of his preconceived opinions and is apt to wish the pesky thing was in hades, or some place as remote. After about 2 weeks' experience he begins to get acquainted and realizes it's not such an awful bad thing after all.

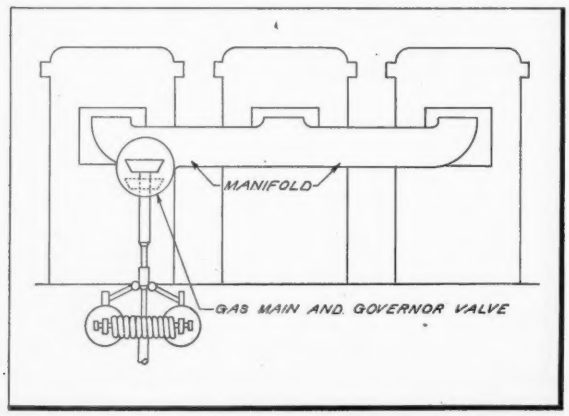


FIG. I. MANIFOLD ARRANGEMENT THAT GIVES TROUBLE

For the benefit of those who take up the gas engine the following ought to prove of value. Only engines using carburated gas will be dealt with here, although most of the troubles and like remedies are met with in engines using producer, natural blast furnace and illuminating gas as fuel.

Carbureter

MOST carbureters for stationary work are of the puddle type wherein raw gasoline flows over a number of baffle plates, is broken up into thin sheets, and combines with air from the air intake of the carbureter. The most frequent forms of carbureter troubles are improper mixtures, failure to vaporize, which is more a fault of poor gasoline than of the carbureter, and accumulation of dirt and water. Usually a rich mixture is best for starting and is obtained by flooding the carbureter with gasoline and closing off the air at the engine. After the engine has started the mixture may be weakened a little, and then gradually weakened more and more as the engine and carbureter warm up. The quality of the mixture can only be found by the man at the throttle as the quality of the air varies from day to day.

Failure to vaporize is caused chiefly by poor gasoline, although good gasoline will vaporize slowly at temperatures of 0 deg. Centigrade or 32 deg. F. At extremely low temperatures the carbureter should be warmed if this is possible readily, if not inject a little raw gasoline into the cylinders. The engine should then start quickly and continue to run; if it should stop after a few explosions it is a good indication of very poor fuel. The surest way to prevent a recurrence of this trouble is either to throw out the poor gasoline from the tank or bring it up to 0.66 or 0.72 by the addition of 0.86 gasoline. Care should be exercised in handling 0.86 gasoline as it is dangerous to take any chance with it where there is an exposed flame or occasional spark even at quite a distance. Trouble will be experienced in vaporizing gasoline at or below 0.66 or 0.62 at temperatures below 50 deg. F.

As most puddle carbureters are provided with an over-flow, it will be seen that that gasoline which is best will vaporize first, while the poorer fuel returns to the tank to be pumped again to the carbureter and returned. Thus it is that after each day's run the gasoline is weaker than on the preceding day. After this condition prevails until a number of thousands of gallons have been put into and taken from the tank, and the tank allowed to get nearly empty, it will be found almost impossible to start the engine. The remedy is obvious.

Water will get into gasoline or manifest itself after conditions as the above have prevailed and this is a most disagreeable trouble. As for dirt, preventative methods and frequent cleaning are the only cures for troubles consequent to dirt accumulation.

Ignition Troubles

IGNITION troubles are perhaps more frequent than any others connected with the gas engine. Batteries of the dry-cell type are seldom used on large engines. This greatly reduces the possibilities for ignition troubles. The magneto or a 100 to 120-volt direct current circuit are the methods most commonly employed to furnish ignition current. Storage batteries are much used for starting and emergency purpose.

If the magneto is properly oiled and the contacts of the distribution plate and rotating segment distributor kept clean trouble will be very rare. In the jump-spark system of ignition where spark plugs are used, care must be exercised in keeping the plug clean of oil, or carbon deposit will gather on the plug. Gasoline rubbed over and well into the plug with a tooth brush affects the oil and carbon and produces a good, clean plug. The same method of cleaning works equally well on the contacts of the make and break system of ignition. Sandpaper may be used to advantage with this latter system of ignition, as a bright surface is thereby obtained.

The oil in the crank case should not be allowed to rise above the mark on the observation glass with which most makers equip their engines. It is surprising how a very small rise of the oil level will produce unpleasant results. The oil is carried up by the piston and eventually finds its way to the spark plug or contact pieces of the make and break system which become thickly coated with the oil which now contains much carbon deposit. The make and break systems are not so liable to disorder from oil, because of the rubbing action of the hammer on the electrode, which tends to insure a clean surface. The oil coated plug will miss, and finally cease firing altogether. The best and surest way is to remove the plug and clean it.

Manifold Arrangement

WITH some makes of engines a peculiar trouble presents itself which is as puzzling at first as it is simple after finding the cause. This trouble arises from the design of the manifold and the relative position of the governor to the cylinders. Engines having 3 cylinders are the ones most usually affected by this trouble. Where the manifold and governor are constructed as in the accompanying illustration, and the load is very light with a rich mixture present, cylinder 3 will be found to be giving no impulse whatever, or at best only occasionally. The operator firmly believes the magneto or plug or part of the ignition current to be at fault, and, on examination, is surprised to find everything in good order.

The cause of the trouble is that the mixture being rich or of a large quantity, the governor closes the main supply valve almost entirely. Cylinders 1 and 2 will fire regularly, while cylinder 3 gets no gas, and consequently gives no impulse. Now, if the load be suddenly and heavily thrown on the engine, the speed is reduced, the governor responds by opening the valve and the heretofore dead cylinder immediately starts firing and continues to do so without a miss. Weakening the mixture will produce the same results, but is often a process requiring more time.

Poor Contact

SOMETIMES one cylinder will miss and fire at irregular intervals, and after extracting the plug it is found to be alright. When the plug is replaced and the engine again started, the cylinder fires regularly with seemingly no reason for its previous bad behavior. The reason is that the contact cap of the plug was loose, producing very poor contact. When the plug was replaced the cap was screwed down tight and the operator has unconsciously eliminated the trouble. Cases of this kind are what cause the average man to regard the gas engine as something possessing instinctive or intellectual powers to do what it wants to when it wants to.

Troubles of a like nature will occur when the defective contact exists at the magneto end of the ignition circuit.

The steam engineer upon first taking up the gas engine will usually become startled from an ignition trouble that produces a very severe knock in the cylinders. It sounds as though the piston was striking the cylinder head with sledge-hammer blows of great force. A knock of this kind in a steam engine means something—something of a grave and serious nature—not so was the gas engine.

The cause of this trouble is due to retarded sparking and suffice it to say will vanish as soon as the spark is advanced.

A dirty or oil coated magneto will give trouble of a disagreeable kind, especially when only the one source of ignition current exists and to stop means loss of money to the management.

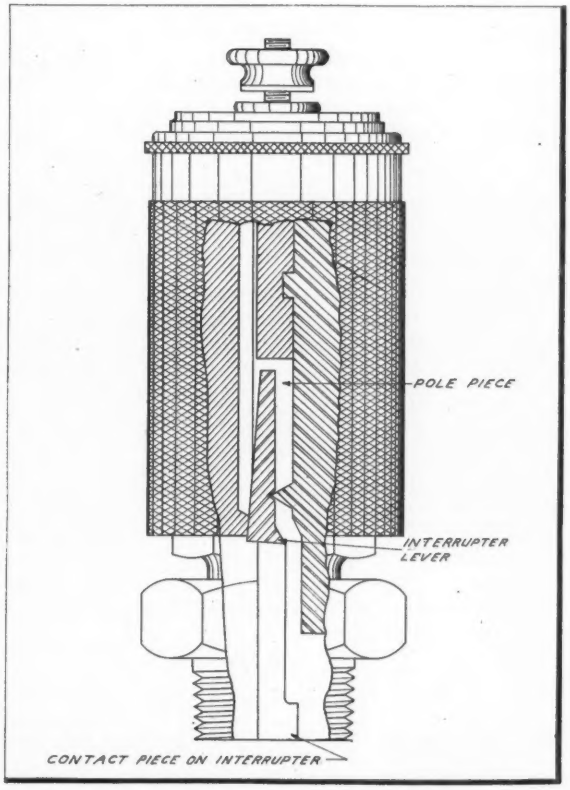


FIG. 2. BOSCH MAGNETIC SPARK PLUG

The rotating distributor segment and contact pieces of the distribution plate on the magneto are sure to become oily in time. If these are cleaned once a week with cheese cloth dampened in gasoline, much time and trouble can be saved, and peace of mind be the engineer's, which is one of his most valuable assets.

Magnetic Plugs

IN ignition systems using magnetic spark plugs, as in the case of the Bosch-Honold system, plug troubles may arise from an accumulation of dirt or rust between the interrupter lever and the pole piece. This accumulation prevents the make and break action of the contact piece at the end of the plug. The contact piece is attached to the interrupter lever, and this lever is mounted on a steel knife edge, as shown in the illustration. Trouble of this kind is the direct result of negligence, as the design of the plug is such that very little attention is required to keep it in good working order.

Compression

COMPRESSION is of the utmost importance in gas engine operation, as the power and fuel consumption depend upon it. Broadly speaking, the lower the grade of fuel used the higher may be the compression; and the higher the compression consistent with safety, the more economical will be the engine.

To keep the valves ground to a good fit in their seats, to have the piston rings fit snugly the cylinder bore, and to adjust the distance between the end of the valve stem and the lifting rod to about 1/64 in., is to insure good compression and silent running. Poor compression not only results in loss of power, but if very poor will be unable to create a suction in the gas main powerful enough to draw the gas to the manifold.

Troubles Due to Wear

THE cams, rollers, etc., will, of course, wear down in time, and should this condition be allowed to continue, the engine will operate very unsatisfactorily. The result of such wear lessens the amount of opening of the admission valve and prevents sufficient gas entering the engine to give a good charge. The exhaust valve will also be late in opening and too much back pressure results.

Cooling Water Temperature

AFTER the cooling water has passed through the engine it enters the carbureter in a warm state, thus heating the carbureter and greatly helps in vaporizing the fuel. The temperature of the cooling water should be suited to the kind of fuel used. For gasoline of 0.72 or even 0.68 test, 120 deg. F. is a good temperature; for 0.56 or 0.58 gasoline, 130 deg. or even higher temperatures may be used to advantage.

Engines using producer gas, natural or illuminating gas, or blast furnace gas, may be run with an average rise of from 50 to 70 deg. between the outlet and inlet water. Thus, if the inlet temperature was 40, 90 or 100 deg., it would be a good outlet temperature. Where water is scarce or expensive, it is necessary to carry higher temperatures.

IN THE GAS PLANT

Notes on Treating Gas Strangling; Gas Engine Piston Rings

BY J. O. BENEFIEL

ONE of the difficulties of operating a producer gas plant where a pressure has to be carried on the generators to help force the gas through the mains to furnaces, etc., is to find and keep men who can stand up to the work in the gas laden atmosphere.

In the works of which I have charge we make a scrubbed gas from soft coal for small furnace and engine work, in order to maintain a pressure of 6 in. water on the mains it is necessary to carry about 2½ in. pressure on the generators and coolers. This causes much gas to escape from the poke holes, hoppers and any place else it can get out, poisoning the air to the extent that only the exceptional man can stay on the job. It does not seem to injure their health further than to cause violent headaches and vomiting. Two of the men have been on the job 2 yr. and seem to be in good health.

Keeping the fire bed of a 12-ft. generator in a shape to make good gas is a laborious job even with pure air to breath. We have a plan for overcoming this which we hope to be able to put into execution soon, if we get it going will describe it for the benefit of readers. The successful gas producer will be a machine that automatically feeds its coal and keeps a solid level firebed as well as discharging the ash, such a producer will make a gas of 160 to 200 B.t.u. per cu. ft. 24 hr. a day, 7 days a week from almost any kind of coal. At the present time there is more 120-B.t.u. gas made than 150, principally on account of the inability of the men to maintain a solid firebed.

But to return to the subject of operating conditions, buildings housing generators should be built with a free exposure on all sides and should have many doors and windows that can be thrown open so the wind will keep the room free of gas. Those in charge of gas plants should be familiar with the best methods of taking care of persons overcome with the gas. It is not often the same man gets an overdose twice but occasionally when the men are overhauling the apparatus one or more of them will go to sleep—without choosing his bed. In such a case we carry them some place where the air is warm and pure (always keep the patient out of the cold), get the oxygen tank and turn the oxygen into his lungs. Usually they revive in a half hour or so and experience no ill effects except a severe headache the rest of the day, unless as happened in a recent case the patient has a chew of tobacco in his mouth which he swallowed while unconcious. There should always be 2 tanks of oxygen at hand as one may leak away and when you want it you want it badly. In many cases I call a doctor for fear the patient may have a bad heart. We have had 3 men down at once, one in the upper part of the building, in this case you want to know how to tie a rope around a man in a way that he can't slip out while being lowered to the ground floor.

A man who has been overcome with the gas will always be looking for the symptoms, which are a shortness of breath and rapid beating of the heart. The inexperienced will not notice these things and as a result somebody will come around and find him on the floor. We always have a close watch kept if we think there is any danger because it will certainly kill if one gets enough of it.

During the annual shut down, while we were overhauling, we took the pistons out of the gas engine which has been running 2 yr. on producer gas expecting to find the rings in a bad shape but to our surprise they were in fine condition and apparently would have run 2 yr. more without attention, being entirely free in the groove. Those rings were beveled on the side next the crank which allows them to ride over the oil and carry it to the head end of the cylinder on the return stroke, this is a good feature. Another good point in these rings is that the outside next the cylinder is turned except about 1/16 in. at each edge, when the engine is first started these edges wear rapidly coming to a good fit quickly.

FIRE LOSSES IN THE United States and Canada in 1911 were $234,337,250, most of them due to carelessness. If buildings in the United States were as fire proof as in Europe, the annual cost of fire losses and protection would be only $90,000,000.

THE SUCCESS of a race horse depends very much on having a jockey who knows how to bring out all its natural speed. Some really capable men do not succeed because they are not well bossed.—Mahin Messenger.

CRUDE OIL GAS

Power from Crude Oil by Means of the Gas Producer and Gas Engine

THIS producer is designed primarily for the heavy asphalt base crude oils of the West and Southwest. It will operate on any grade of crude or fuel oil above 10 deg. Baume, which is the heaviest the manufacturer has had an opportunity to try. It gives exceptionally fine results on the 15 deg. asphalt crude oil common in Southern California.

The producer is operated mechanically at a dull cherry red, at which temperature the deterioration of the linings is slight, especially in view of the fact that no clinker forms on these linings, and the use of a slicing bar is not necessary. On account of this low depreciation and low attendance cost, the producer is available in localities where the price of crude or fuel oil is greater per horsepower than the price of even such excellent producer fuels as anthracite or the low ash bituminous fuels of the Pocahontas class.

It is true that for sizes from 50 to 200 hp., a gas oil engine, such as the same company builds under the Rumely patents, gives cheaper cost of power, because engines of this type using this low grade gas oil which is handled in a carburetor, do not need attention, except to stop, start, and an occasional look at the oil cups, while an oil producer would need more regular supervision, although in these small sizes this would not take up to exceed half of the operator's time, but the low fuel cost of the gas oil engine is offset in a great many instances by the fact that the gas is needed in these small plants for other purposes than power and the gas which this producer makes is exceedingly well adapted for heating, brazing, and similar operations; take for example manufacturing jewelers, they need power but need also a soft flame, such as they would get from city gas, and they also need a hard, fierce flame, such as they now manufacture from 74 deg. gasoline, which they use in connection with plated work. With proper nozzles both of these flames can be secured from this standard power gas, which makes a set of this sort desirable for manufacturers having this combined power and gas proposition.

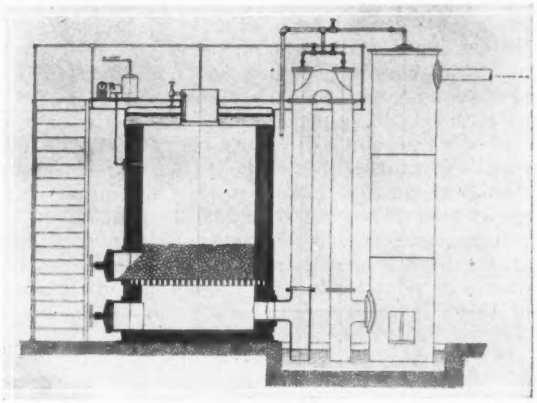
The great field for this producer, it is thought, will be for marine purposes. As compared with crude oil engines, for example, it would occupy more space and would have a larger consumption of oil per horsepower. On the other hand, the weight of the combined unit would be no greater than that of the oil engine by itself, and due to the fact that it will handle any grade of oil which is fed to it, and will give as high efficiency on the lowest grades as it does on any other.

In favor of the combined proposition for marine purposes, would be the simplicity of the apparatus, and especially the simplicity of the engine in which this gas would be used.

The latest step in the development of the oil producer, is embodied in the Wisconsin crude oil producer, made by the Wisconsin Engine Co., in which the oil is sprayed in a finely divided state into a chamber at the top of the producer, water vapor and air being admitted in proper proportions along with the oil. Partial combustion or conversion into gas takes place in this upper zone at a temperature which causes a deposit of a considerable amount of coke and carbon, which falls by gravity into the fuel bed at the bottom of the producer. The producer works on the down draft principle, and this coke bed acts in the double capacity of a filter bed and of a fixing bed, filtering from the gas all except the very lightest particles of carbon and fixing the unstable gases generated in the upper zone of the producer. The issuing gas is, therefore, a permanent gas which requires little additional cleaning. The average composition of this gas from a 14 deg. Baume asphalt base crude is as follows: CO_2, 6.2; O_2, 0.3; C_nH_{2n}, 1.0; CO, 15.1; CH_4, 5.4; H_2, 4.6; N_2, 67.4; B.t.u. 143.0.

This gas is low in hydrogen and high in heat value, making an exceedingly desirable gas for power purposes. The system is flexible in its operation and the heat value of the gas can be decreased or slightly increased without seriously affecting the hydrogen content. With the lighter oils of our Eastern territory, the composition of this gas would be somewhat different and its heat value probably somewhat higher.

Temperature of the producer is that corresponding to a dull cherry, which is favorable to long life of the producer and its linings. The supply of oil, water vapor and air required for the producer, is automatic-



THE WISCONSIN CRUDE OIL GAS PRODUCER

ally regulated in proportion to the load. The scrubbing apparatus is merely an inverted "U" tube into which sprays of water are passed through the gas and remove 90 per cent of the impurities.

The passage of the gas after this through a standard form of coke scrubber is all that is necessary to bring it to an entirely satisfactory degree of purity. It should be noted particularly that no tar is formed with this process. The washers have, therefore, the comparatively simple problem of removing the small particles of coke and carbon which are not caught by the hot filter. The hot filter can be formed of coke or anthracite coal, or practically any carbonaceous material.

The producer has been operated with a bed consisting originally of blocks of wood, which gradually reduced to a charcoal; peat has never been tried but undoubtedly would serve the purpose equally well. Preferably, however, coke is used on account of its porous character and because of the fact that the deposits made in the process of generation of oil are themselves of similar nature. With California oils it has been found that on 24 hr. service, the depth of the fuel bed is automatically maintained. If the shut downs of the plant have been frequent, a small amount of coke will need to be introduced to replace that lost during the shut down period. The height of the coke bed is always under control by regulation of the amount of air admitted.

COOLING PONDS

Dimensions Required and Temperatures Obtained With and Without Spray Nozzles

By A. G. Eneas

On page 49, January 1st issue, correspondent C. D. requests information on a cooling pond for condensing engines of 100 hp., also the additional area necessary for each 100 hp. up to 1000 hp.

A similar question pertaining to a 3000-hp. plant was asked the head of the mechanical department of one of our leading Massachusetts technical institutions, and on learning that the designing engineer proposed to build the cooling pond without a spray system, he facetiously replied: "Make your pond as large as Lake Erie." For the benefit of the correspondent and readers, I submit the following data:

For the area of a cooling pond without sprays, allow 1 sq. ft. for every 4 B.t.u. to be dissipated per hour per degree difference of temperature between the air and the hot water. This applies to summer temperatures. During the winter time, the amount of heat lost per sq. foot per hour per degree difference of temperature as above noted, will not exceed 2 B.t.u., under average weather conditions.

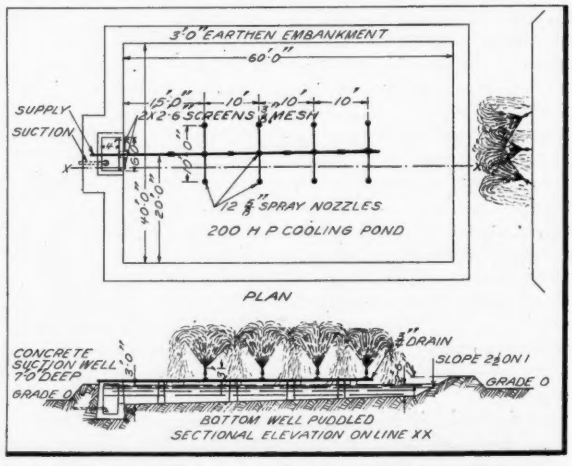
On this basis, and assuming the engine requires 25 lb. of steam per horsepower-hour, there will be required approximately 150 sq. ft. of pond surface per horsepower, so that a pond for 100-hp. engine should have an area of not less than 15,000 sq. ft. Even with this large area, it will not be possible in the Central and Northern States to cool the water sufficiently to obtain a vacuum much better than 22 in. in the winter, and 18 in. in the summer, which can hardly be considered satisfactory.

In any case, the suction well should have removable screens with submerged openings, so that the hot surface water would be prevented from entering it. The inlet to the suction pipe in any type of pond should be submerged 6 ft., as it would otherwise be likely to form small whirlpools, and thus draw in air with the water, and so lower the vacuum in the condenser, when it was operating.

If however, a suitable spray arrangement is installed in the pond, its area can be greatly reduced. Based on the weather conditions prevailing in the Central and Northern States, for plants of 1000 hp. allow 1 sq. ft. of pond surface for every 250 lb. of water sprayed. Smaller plants will require a proportionately greater area of pond surface, as it is desirable to keep the sprays not less than 15 ft. from the limiting edge of the pond in any case, and preferably 20 ft. The circulating water necessary for the condensers may be assumed as 30 times the weight of the steam used in the engine, if a 25-in. vacuum in the summer, and 26-in. vacuum in the winter is considered satisfactory.

For 100-hp. plant, we would suggest a pond 40 by 40 ft., equipped with 6 5/8-in. spray nozzles as shown. For 200-hp. we suggest a pond 40 by 60 ft. It will be noted that whereas 16 sq. ft. are required per horsepower for the smaller sized pond, only 12 sq. ft. per horsepower are required for the larger sized pond. For 1000-hp. plant it will be found that an allowance of 4 sq. ft. of pond surface per horsepower, when equipped with sprays, will be ample to afford a good vacuum at all seasons of the year. For a plant of 100-hp. we would suggest using a nozzle having a smaller orifice than 3/4-in. as the smaller the nozzle the finer will be the spray at any given pressure, and the finer the spray, the greater will be the cooling effect. A 3/4-in. nozzle at 8 lb. pressure would discharge approximately 350 to 400 g.p.m. according to the make of nozzle used. The height of spray would approximate 8 ft. A 5/8-in. nozzle would spray about 250 g.p.m. when operated at 8 lb. pressure per square inch, and would project the spray to a height of approximately 8 ft.

The cost of spray nozzles is so little compared with the benefits that they afford, when properly installed, that I suggest their use in every case in preference to a pond without sprays. The amount of cooling which will be obtained from the use of a spray pond will be sufficient during the summer months to



PLAN AND SECTIONAL ELEVATION OF COOLING POND WITH SPRAY NOZZLES

reduce the temperature of the discharge water to approximately the temperature of the surrounding atmosphere.

In very hot weather, the final temperature of the water after spraying should be 5 deg. or more higher than that of the surrounding air. It should be noted that a spray system which will cool the discharge water from 90 to 72 deg. F., with the air temperature 70 deg. F., and the relative humidity 70 per cent, will also cool water having a temperature of 110 deg. or 120 deg. F. to 77 and 80 deg. F. respectively, with air temperature and humidity, as above noted.

No mention has been made of the depth of the pond equipped with sprays, as a pond 10 ft. deep possesses no marked advantages over one 2 ft. deep, except that it gives a larger water supply.

Standard commercial spray nozzles can be bought at prices varying from $10.00 to $15.00 each, according to make.

"Economy" is the ever present needful of the engineer as of all who are in positions of responsible trust, but the man who had it so thoroughly ingrown that when a head-on collision was inevitable grabbed the oil can and a lump of coal and jumped, seems to have gone a bit far in the direction of saving.

OIL BURNING SETTINGS

Tests of Different Furnaces and Draft Conditions With Horizontal Tubular Boilers

THESE TESTS WERE MADE on a 72 in. by 18 ft. boiler by Professor Kerr and H. A. Nadler of Louisiana State University and A. & M. College. The boiler was at the Smithfield sugar factory.

Draft from a single stack served the battery of 3 boilers, one of which was used in making the tests, all which, with the exception of the last 2, were made with a Higgins burner.

First Arrangement

AS shown in Fig. 1, this setting was arranged so that air for combustion came to the under side of the grate through a long duct from the back end of the boiler setting. Behind the bridge-wall this duct was covered with brick loosely thrown in, so as to heat the air before it reached the burner. The amount of opening of this duct could be controlled or closed.

Draft-doors were tightly closed by means of brick and mortar, and fire-doors were closed in the same manner, excepting for 2 openings of about 2½ by 4½ in. each, which were used as peep holes; when the boiler was in operation, these were entirely closed by the insertion of bricks, so that the entire front of the furnace was closed, and all air admitted came from the rear of the setting through the brick duct. The air thus delivered to the under side of the grate was admitted to the furnace above through an opening 4 in. between the front of the grate and the front of the furnace wall, the grate, with this

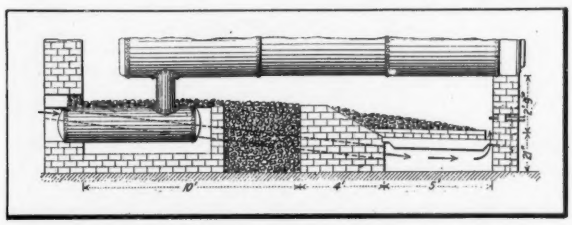


FIG. 1. SETTING WITH DUCTS FOR PREHEATING AIR

exception, being bricked solid. Grate-bars were covered with 2 layers of firebrick laid flat, so that there was no possibility of air flowing into the furnace except through the 4-in. opening at the front. On this flat surface broken bricks were thrown in loose to give a gradual slope from near the front of the grate up to the top of the bridge wall. In these tests, as in all others, draft was regulated by a damper in the flue leading to the stack.

Tests with this setting are given in the table, Nos. 1 to 8, and show that the poorest conditions, No. 7, were with ¾ load and damper fully open, giving flue draft of 0.282 in., and next to poorest, No. 3, with normal load and flue draft of 0.092 in. Best economy was obtained in No. 5 with load at 106 per cent of rating and flue draft of 0.175 in.

Study of draft, load and flame conditions as given in the table shows that, as would be expected, best results come from a draft so adjusted to load that the clear flame fills the furnace, giving the right air supply, without excess and sufficient time for complete combustion.

In the second arrangement, the setting was arranged at first with no broken brick above the flat layers and with flat bricks in front of the bridge wall separated to leave 7 holes ½ by 8 in.; otherwise the setting was as in the first arrangement. This gave too much air at the bridge wall so that flame struck the boiler shell at one spot. Gradual closing of the holes reduced the air at this point, but even this, and throwing loose brick above the holes, did not give satisfactory air distribution, so that only one test was made, No. 9.

Third Arrangement

ARRANGEMENT was made for preheating the air by passing it through fire-brick passages directly under the furnace, Fig. 2. Grate bars were lowered almost to the ashpit floor and a checker work of brick was built without any mortar so as to give the desired path to the gases as indicated.

To diffuse the fuel and mix the air and the gases, a checkerwork wall was built above the floor of the fur-

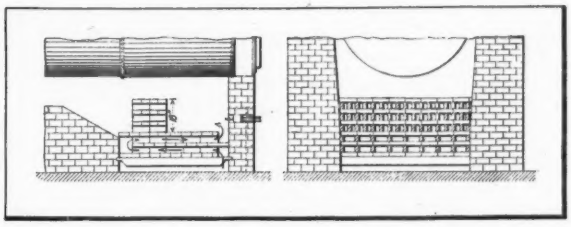


FIG. 2. CHECKERWORK ABOVE LOWERED GRATE TO PREHEAT AIR

nace. Air ducts from the rear of the setting were closed and all air entered through an opening of practically 1 sq. ft. in the ashpit door.

Owing to factory conditions, it was impossible to carry the full load while running with this setting; but as underloading reduces efficiency, it may be assumed that the evaporation per pound of oil would have been better for this setting under normal load. Nothwithstanding this, the results compare favorably with those in setting No. 1.

In the fourth arrangement, the checkerwork used for diffusing the gases in setting No. 3 was replaced by loose bricks sloping gradually from near the front of the grate to the top of the bridge wall. As with setting No. 3,

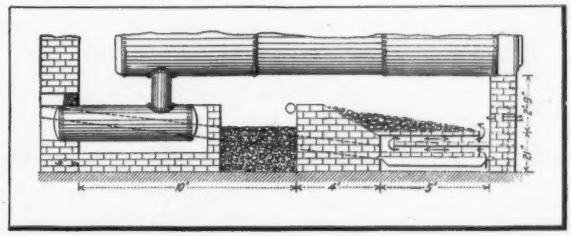


FIG. 3. CHECKERWORK USED FOR PREHEATING; ADDITIONAL AIR BACK OF THE BRIDGE WALL

the air was preheated by passing back and forth under the furnace, all air being admitted from the front.

Test No. 14, with this setting, was made with air supply adjusted in the light of former tests, to give the best possible results. The lower evaporation per pound of oil, 14.88, was, therefore, somewhat unexpected, especially in view of the favorable conditions as regards load and excess air. But test No. 15, under practically the same conditions, gave an evaporation of 15.38 lb., due

partly, perhaps, to the boiler tubes being blown out just prior to this last test.

Fifth Arrangement

THIS setting, Fig. 3, was the same as No. 4, in front of the bridge wall. In all of the previous settings, however, that part of the combustion space back of the bridge wall was filled with firebrick to the level of the top of the bridge wall.

With the idea of investigating the value of this space for combustion, loose bricks were removed to a depth of about 15 in., although the brickwork around the mud-drum prevented this enlargement all the way back. To admit some air back of the bridge wall, a 4-in. pipe with a number of 1-in. holes in it was inserted through a hole in the side wall of the furnace just back of the bridge-wall. The holes were located so that the air entering would be discharged upward at right angles to the current of gases.

As in the previous settings, the air entering at the grate came from the front of the furnace, although the opening in the ashpit door was nearly closed.

Aside from tests 22 and 23, which were made with burners of a size insufficient to carry the load, the lowest evaporation was that in test 17, in which the damper was closed to such a point that the furnace was filled with a rolling flame, a condition accompanied by a low efficiency in the other settings. The damper was closed too much in test 16, although not quite so much as in 17. The remaining tests showed very good results.

It will be noted that the excess air was lower in these tests than in most of the others, which may be due to the admission of air through a pipe at the rear of the bridge wall and to the enlargement of the combustion space back of the bridge wall.

PRINCIPAL RESULTS FROM TESTS WITH DIFFERENT SETTINGS

Test Number	Conditions of Test	Steam Pressure, Gage	Flue Temperature Deg.	Draft in Flue, Inches of Water	Draft in Furnace, Inches of Water	Per Cent. of Rated H.P. Developed	Evaporation from and at 212 deg. per Lb. of Oil	Steam for Atomizing, Per Cent. of Total	Excess Air, Per Cent.	Efficiency of Boiler, Per Cent.	Efficiency of Boiler and Furnace, Per Cent.
	SETTING NO. 1										
1	Steady load; no smoke	74	403	0.117	0.089	81.5	14.35	2.89	107	71.6	69.5
2	Heavy long flame; damper wide open; ashpit doors closed; air from back of setting	81	402	0.224	0.164	102	15.41	5.98	97.5	76.6	72.3
3	Smoky rolling flame; no smoke from stack, air from back of setting; steam valve on burner wide open	70.9	449	0.092	0.102	99.1	14.06	6.15	65.9	70.3	65.2
4	Long heavy rolling flame; damper wide open; air supply from rear, high velocity of gases	76.2	466	0.320	0.251	117.6	15.32	3.85	124	76.3	73.5
5	Whitish yellow flame at front ending with blue at rear. Draft less than in No. 4; steady load; as little steam as possible used in burner	88.2	454	0.175	0.132	106	16.1	6.28	.....	80.1	75.2
6	Fire rolling and completely filling combustion chamber	88.4	463	0.162	0.132	110	14.41	4.44	53.8	71.8	68.7
7	Air ducts from rear closed; air supply from opening in ashpit door; short white flame; damper wide open	88.5	461	0.282	0.227	75.3	13.2	5.19	184.8	65.6	67.5
8	Conditions similar to No. 7, with damper opening slightly changed	85.3	476	0.11	0.11	89.3	15.75	5.25	69.1	78.4	74.4
Average		81.56	446	0.185	0.151	97.6	14.83	5.00	96.7	73.8	70.8
	SETTING NO. 2										
9		81	483	0.147	0.126	99	14.46	4.85	64.8	72.1	68.5
	SETTING NO. 3										
11	Medium draft, clear fire, flame slightly blue and ending just back of bridge-wall	80.7	489	0.235	0.149	86.2	14.45	6.57	121.2	72.1	67.2
12	Draft less than No. 11 and short, transparent flame	85.3	476	0.171	0.12	80	15.56	5.89	114.8	77.5	73.0
13	Boiler washed out previous to this test	81.9	460	0.20	0.13	89	15.26	5.0	106.2	76	77.2
Average		82.6	475	0.20	0.13	85.1	15.09	5.82	114.1	75.2	70.8
	SETTING NO. 4										
14	Transparent white flame ending just back of bridge-wall; firebrick very hot	84.3	462	0.175	0.158	104	14.88	3.67	89.3	74.25	71.5
15	Tubes blown just before starting test; flame white and opaque; draft higher than in No. 14	86.75	462	0.222	0.202	103	15.38	5.26	89.3	76.6	72.7
Average		85.52	462	0.187	0.180	103.5	15.13	4.46	89.3	75.42	72.1
	SETTING NO. 5										
16	During first hour, clear bluish rolling flame; later, shorter flame due to increased air supply	85.8	417	0.159	0.155	84	15.18	4.41	65	75.6	72.4
17	Load steady; damper closed; heavy bluish flame at front, clear at back	86.9	454	0.184	0.182	109.5	14.70	2.25	37	73.2	71.5
18	Same as No. 17 except more draft; steam valve wide open	80.8	479	0.253	0.258	123	15.56	3.2	55.5	77.7	75.0
20	Long white opaque flame; damper such that further closure would cause flame to enter tubes	88.8	456	0.197	0.170	109.5	16.05	2.37	75.5	80.0	78.2
21	Heavy draft	85.5	472	0.345	0.262	106.2	15.31	3.21	88	76.4	74.0
Average		82.1	456	0.227	0.205	106.4	15.35	3.09	70.2	76.6	74.2
22	Von Phul burner used at full capacity; white flame	83.1	432	0.210	0.161	69.8	14.05	3.00	108.5	70.2	68.0
23	Home-made burner	84.7	419	0.175	0.145	69.4	14.22	3.19	.....	71.0	68.8

Results

TESTS showed that the amount of steam used in atomizing depends largely upon the operation of the burner, a white flame being usually accompanied by small consumption of steam for atomizing and transparent red or orange flame by a large quantity of steam. The average percentage of steam used for atomizing (about 4.38) is fairly good, although 2.5 to 3 per cent can be obtained under proper conditions. This column shows that the percentage of steam used for this purpose decreases with the load.

Increase in economy due to proper draft regulation is plainly shown by the results of the tests, although certain

variable conditions, such as load, made the results due to changing the draft less regular than they otherwise would have been. The average difference between furnace draft and flue draft was about 0.04 in. of water, this difference representing the friction of the gases in the boiler tubes and passages. It might have been expected that this difference would have been greater as the load increased, due to increased volume, and therefore greater velocity of the gases. But, in general, there was less excess air at the greater loads.

With the flue damper wide open, flame in the furnace moved at high velocity, tending to break up and disappear at or near the bridge wall, the color being rather light. Upon gradually closing the flue damper the velocity of the flame could be seen to decrease, the flame extending farther and farther toward the rear of the setting and becoming denser and redder.

By continuing the gradual closing of the damper a point was reached where the velocity was low and the flame would roll, the furnace setting being entirely filled with dense and generally smoky-looking flame, but without smoke at the top of the stack. The tests showed that this latter appearance is an indication of a condition near that which gives the best efficiency and that by setting the damper at a position just short of this rolling action of the flame, the best effect is obtained.

Since the best boiler efficiency is dependent not only upon proper air supply, but also upon proper loading, it is best, as far as possible, to take care of the variations in load with as few boilers as possible. In other words, instead of slightly reducing the fuel supply to all of the burners when the load is reduced, it is better to make the reduction with one or 2 boilers and not change the others.

ENGINEER'S CALENDAR

Holidays that Were Not Holidays

By G. H. Wallace

I AM going to invent a new kind of a calendar for engineers only. There wont be any nights, Sundays, or holidays on it. What's the use? He never gets the use of these highly desirable periods anyway. We shut down Thursday, Dec. 21 last till Tuesday morning, so I cut out a boiler to wash and put in a new set of arch brick. Friday at 11:30 they sent word down that the "high guys" was a-comin' with a bunch of billionaires at 1:30, and they wanted to see the "whole works" in operation. Well, there I was with only one boiler, which was then doing a good 200 to 250 b. hp. The other was washed and repaired, but was empty yet and the plates not in, so there was nothing to do but "to go to it," and go to it we did. I learned that they were not going to stay only about 2 hours, and I calculated that the boiler would not melt up entirely in that time, so we cut loose.

I got a man to pick out the best coal. He almost examined the pieces with a microscope to see if they were pure carbon. Our load on the board was from 600 to 1000 amp., 225 v., and this means about 275 to 450 i. hp., besides a 105 i. hp. hydraulic pump, an air compressor 40 hp., 5 other pumps, and a live steam load that varies from 100 to 200 b. hp.

The fireman pulled the damper out by the roots. He had it out to the last notch (the 11th). Ordinarily we run in the 6th. The fire was a dazzling white heat and the fire brick arch began to drip, something it never did before even on the big test last April. But by golly we got away with it. If that bunch don't subscribe for about $75,000,000 of stock, they ought to be hung by the heels.

Saturday a piece of babbitt fell out of the recess around the nut on the h. p. piston rod of the air compressor, and as there was no place else to go, it started to fill up the clearance and compress from ⅞ in. sq. to less than ⅛ in., all at one squeeze, and the machine "stopped short, never to go again till," etc. Trouble never comes singly. Well, I had a whole regiment. Two helpers quit "because the work was dirty." So with 2 men I got the machine apart and together again by 6 p. m., so I took a "bawth," changed my clothes and went down to church to play Santa Claus, with no supper. "Still the villain pursued me." I was engaged to play the part "and found" —well they "found" me all right, but someone blundered, like they did at Balaklava, and no one had seen about my Dr. Cook costume.

At the last moment, 2 of the boys rushed out, scared up a fur coat, a false beard, a pair of leggings and a fur cap. I got my rig on when they were singing the last verses of the hymn that was to be my cue. If that bunch of kids ever find out how close old "Santy" came to missing his airship connections, they would have 17 fits.

Then there was our own tree to trim and supper to eat when we got home. But, to sum it all up, I got all my work done at 7:30 p. m. the 25th, and now I flatter myself that I am really getting rested.

FIRE WASTE

Due to Our National Criminal Carelessness

THE year has started off with fire losses at the rate of a million dollars a day. While much of this was due to the prolonged and excessive cold weather, yet it does not promise well for the reduction in the fire waste which it was hoped to secure in 1912 as a result of the educational work done last year. The 1911 fire losses were $234,337,250, but the loss for January of this year was 50 per cent ahead of the same month last year.

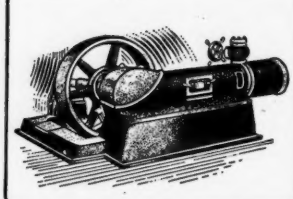
As usual, most of these fires were due to the national fault of carelessness. While zero weather may account for the unusual number, most of them were easily preventable. Overheated stoves and furnaces, defective flues, and the thawing of frozen water pipes with burning paper were the chief causes of the cold-weather fires. But it is carelessness approaching criminality to run stovepipes near wood, to build chimneys improperly and leave them uninspected, to start a bonfire by a lath partition in a home to thaw out frozen pipes, and to do all the other foolish and reckless things that make the fire waste of the country a quarter of a billion dollars a year.

Reduction of this fire waste and its terrible toll of life and property is in the hands of the people. So long as they are indifferent to the ruinous drain upon the national resources involved in this needless waste, so long as they lack the sense of individual responsibility for the proper protection and condition of their own homes and communities, so long will the fires continue to multiply.

Abroad, the man who would throw a match into a heap of rubbish, or who would fail to protect an overheated stove or flue, would go to jail. And the fire losses abroad are 1/10 what they are in this country, while the loss of life is nominal in comparison. With the majority of the fires due to carelessness, individual and municipal, the urgent need is the development of a sense of personal responsibility for greater precautions, especially in such a time as this, and January losses of a million dollars a day help enforce the lesson.

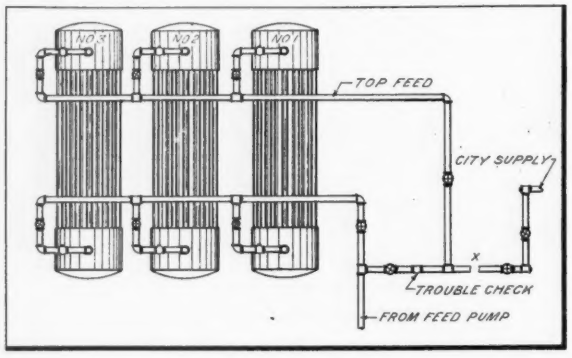
Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



A BAD CHECK

WHEN I took charge of this plant, I had quite a time getting water in No. 1 boiler, as the feed pipe, to the lower drums, seemed to clog up. I asked the fireman if he had the back manhole plate out the last washout. He said no, I don't take them out without orders. We had 2 more days to run before washing out, and to cut one boiler out meant to shut down for want of steam. While we were discussing this, I noticed the water getting lower, and told the fireman to shut off 2 and 3, and when I went back to the boiler feed pump the joints were leaking badly. There was a bypass on that line to feed the boiler in the top, then the coal passer came and said the water was down to the nut. Now something had to be done quick. To shut down meant to fail on the contract. I opened the valve leading from the pump to the top



FEED PIPE ARRANGEMENT

feed. I found the check put in wrong. I called for a 36-in. wrench, told the fireman to open the top feed valve and swung the swing check half around. This dropped the disk, and I got all the water I wanted until Sunday, and from now on the orders are given to take the back manhole plates off; that check came out too. I can't understand why it was put there; it ought to be put at X on pipe line. The sketch shows the piping as it is. John Fredrick.

GETTING TO THE FRONT

I WAS much interested in George's trouble with the consulting engineer, January 15 issue, page 89. It surely was hard on George, but he probably is somewhat like the rest of us, a good enough engineer, but tongue tied. We have always noticed that in any walk of life it is the fellow who is blessed with the ability to express himself who gets the plums, even though he may not be so capable as the silent one.

We engineers should take a course in the art of talking. There is something about the concentration of mind on engineering problems that makes us poor hands at expressing ourselves. Perhaps we expect our work to speak for itself. This don't get us to the goal; we should also be able to present our case in good shape.

But to get back to George's case. If I should get a tip that my employer were aching to spend money for a consulting engineer, I would certainly apply for the position myself and do it hard. I would certainly feel myself as competent to plan buildings, power plants, or anything they would need, as anyone else, and if I knew what was going on I would surely let them know that I felt that way. My motto is to take a shot at it if you have a reasonable belief that you can deliver the goods. We don't get anywhere because we are the silent bunch.

There are millions laying around waiting for the man with the ball-bearing tongue. He got some of mine. J. O. Benefiel.

METER CONNECTIONS

EVERY once in a while we run up against a proposition that cannot be solved by consulting a book; so it is up to the man in charge of the work to study it out for himself.

Our power plant is installed with 2 110-volt generators connected in series to a 3-wire system. After 10 o'clock at night they run only one generator, connecting the 2 outside leads together, leaving practically a 110-volt 2-wire system.

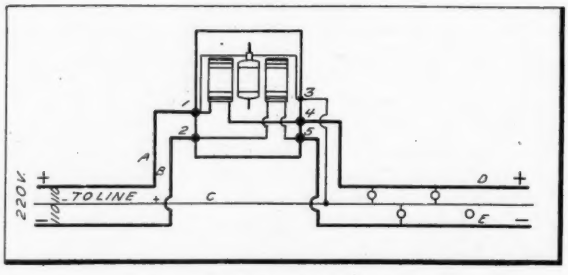


FIG. I. ORIGINAL METER WIRING

We have 10 new buildings here in which are installed 220 volt 3-wire recording wattmeters. Each house has 2 circuits, and until 10 o'clock everything is O. K., as far as the meter is concerned. After that hour, if only one circuit of the house is on, the meter will run either forward or backward, as the case may be. If an equal number of lamps are burning on each circuit, the meter will stand still.

As soon as the people found this out they would keep 1 or 2 lights burning on the side of the house that would cause the meter to run backwards. Then when the end of the month came around, instead of having the meter registering 15 or 20 kw., it would show but 2 or 3 kw.

I was ordered to investigate this case and see what could be done to remedy the defect.

Figure 1 shows the original wiring of the houses and the meters, and is correct until 10 p. m. After that hour the line wires A and B are connected together at the power house and the lights supplied from one generator. It is readily seen, by referring to Fig. 1, that the lead E becomes positive; hence, if the lights are burning on the circuit C-E, the meter will run backwards, because we have reversed the field of the meter, while the direction of the armature current remains the same. If an equal number of lights are burning on each circuit, the fields will neutralize each other and the armature will remain stationary.

The change I made is shown in Fig. 2. The armature circuit is tapped from terminal 1 inside the meter; it is, therefore, essential to use this field in making the change. I disconnected lead B from the meter and taped it to prevent any accidents. I then connected lead E to D at 4, and now our meters run forward at all times.

The 10 houses are all in one row and supplied from the same mains. In the first house I cut out lead B, and in the next one lead A, and placed lead B in terminal 1, so as not to destroy the balance of the system. Using A and B alternately does not change the direction of the meters, because they are wound exactly as a shunt motor. Changing the direction of either the field or the armature will change the direction of rotation, but changing the direction of current of both will leave the direction of rotation the same. These meters are 10-amp., 220-volt, 3-wire meters, and each house has only 10 lights installed; so even if all the lights are turned on at one time the field will be carrying only its normal load.

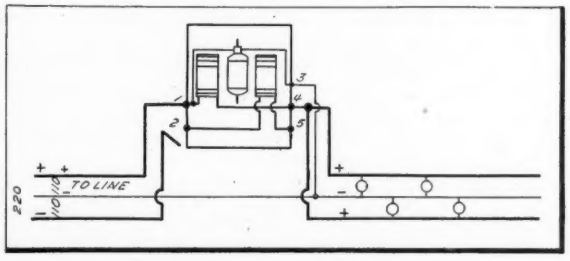


FIG. 2. CORRECTED WIRING OF METER

I tested each meter with a voltmeter and ammeter before and after making the change at ¼, ½ and full load, and found the readings to be the same in both cases.

Leo J. Huennekens.

ENGINE REVOLUTION GAGE

THE engine revolution indicator shown by Mr. Schwindler is not a new idea, but, as he says it does its work, undoubtedly it is a great convenience to him. I take it though that his engine operates under a steady load, as I hardly think it would be of use under changing conditions. The governor he shows appears very similar to one on an engine I ran for 2 yr.

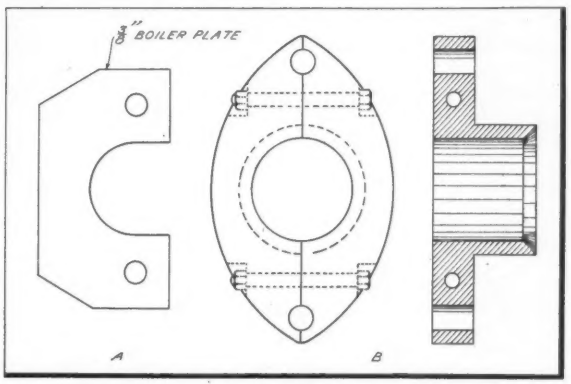
On an engine of the 4-valve or Corliss type where the speed is regulated by changing the position of a weight on an arm or rod, or by increasing, or decreasing the tension on the governor springs, this scale would show some strange things. At the plant where I am located the load seldom remains stationary for any great length of time, and will vary from 600 to 1400 i.hp. on each condensing Corliss engine. When running on light load, and a heavier load comes on, more steam is required, and in order to obtain it the governor has to give a later cut-off, which it cannot do without changing its position, so it drops to a lower plane, where it runs at the same speed as before.

With a load of about 1100 i.hp. our governor will rise about 1¾ in. off its seat at our greatest speed. Noncondensing, and with a load of 1400 hp., at the same speed, and of course using more steam, I have seen it drop down to within ¾ in. of its seat. This inch difference in height would play havoc, I imagine, with Mr. Schwindler's scale as a sober revolution gage. I would suggest that if there is any great variation in the load, he use his watch on the scale at extreme conditions

R. M. L.

GLAND REPAIR

WHILE in a power house, supplying power to a railway repair shop, containing several large duplex pumps I witnessed a quick repair job, when a gland on one of the water cylinders broke. An order was rushed to the boiler shop for a piece of ⅜-in. boiler plate, cut and punched as at A. In 15 minutes the piece was ready for use and did service until a new gland was cast in 2 pieces as at B.



EMERGENCY GLAND AND FINAL REPAIR

Fred Wagner, Engineer.

VISIBLE BOILER ACTION

DISCUSSING boiler explosions, the average engineer gives too little thought, it seems, to what really is going on inside of a boiler working under pressure under different conditions, or they would certainly be more careful in handling such a dangerous apparatus and not leave the care and operation of their boilers entirely in the hands of their firemen, as is often the case. The writer does not mean by this that firemen are incompetent or cannot be trusted; on the contrary, they are, as a rule, a reliable class of men, but the fireman's job being, so to speak, the stepping stone to the engineering profession, he cannot be expected to understand fully principles in connection with steam generation, which many engineers have failed to realize, in spite of years of experience with boilers.

In every meeting place for engineers or firemen there ought to be, among other exhibits, 2 models of shell and water tube boilers, made partially of glass, to withstand safely 15 or 20 lb. of pressure, to permit watching the performance inside a boiler under actual working conditions. With such a model it can be clearly demonstrated how the water acts at a sudden release or change of pressure, also when the water contains large quantities of impurities.

For instance, when firing the boiler under ordinary conditions with steam taken away as fast as generated so as to maintain uniform pressure, the circulation of the water and the ebullition is seen to be fairly constant. Now suppose the flow of steam is suddenly stopped but the fire maintained under the boiler in the same condition, the ebullition stops as soon as the flow of steam is cut off. The heat still applied to the boiler now goes into the water, raising it to a temperature corresponding to the suddenly increased pressure. In a short time, however, or as soon as the temperature has reached the boiling point for the new pressure, the steam bubbles will commence to form again.

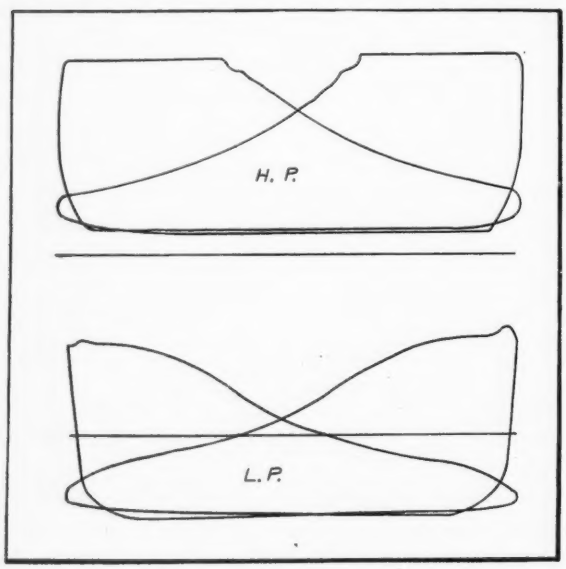
Now try another experiment. After the flow of steam has been suddenly shut off, keep up the fire as before, and after waiting a minute or so, while everything is still quiet inside the boiler, suddenly throw open some outlet to the atmosphere and watch the commotion set up in the water, steam bubbles forming everywhere, and if the water is dirty some of it will be thrown out with the escaping steam. This last experiment should not be tried, however, with more than 5 or 6 lb. of pressure.

Such a model also gives an excellent demonstration of the effect of impurities or chemicals introduced in the feed water, and anybody who has watched a practical demonstration of this kind cannot help having it in mind when performing the same operation in actual practice, firing up and cutting in boilers. It is an established fact that most boiler explosions have occurred at the time of starting up or putting a boiler in commission after it has been down for cleaning or repair, and no doubt many explosions could have been prevented with proper care in handling.

R. Cederblom.

CARDS FROM A FULTON CORLISS

HEREWITH is a set of cards taken from a Fulton Corliss, running at 102 r.p.m., with 160 lb. boiler pressure, 10 lb. receiver pressure and 25 in. vacuum.



HIGH AND LOW-PRESSURE CARDS FROM A FULTON CORLISS ENGINE

I would like to hear from readers of Practical Engineer suggesting improvements. F. B.

VACUUM TROUBLES

IN operating a 630-hp. Slater Corliss cross-compound engine I recently had some trouble with my vacuum; generally carrying about 27 in. the gage registered only 20 or 22 at the most. I could not find where my trouble was, for the pump was working fine. After looking the apparatus over carefully, I mixed up a paste of cylinder oil and flaked graphite and applied to the piston rod with a swab while the engine was under heavy load. I watched the vacuum gage at the same time to note the result, which was all that could be expected, for there was immediately a heavy suction and the gage showed 25 in. of vacuum, only to drop back to 20 in. the next moment.

This indicated a leak around the piston, so a new packing was ordered, and the piston newly packed This brought my vacuum troubles to an end for the time at least, my gage showed 27 in. of vacuum and the pump was working normally. Sometime later my vacuum began again to go back without apparently any troubles of the pump. My chief began to wonder what could be the cause this time, so I began again to hunt for a leak, but with no success; finally as I was oiling the valve gear near the dash pot on the head end of the low pressure cylinder I noticed a slight jet of steam coming from the head of the exhaust bonnet; on investigation I found a slight leak in the head and asked the chief if he knew of the leak. He said he did. Then I asked him if that leak would not affect the vacuum. He saw in a moment that it would. The joint was newly packed and we have had 27 and 25 in. of vacuum ever since. This shows that a small leak will have great effect on the vacuum gage.

Bert. A. Brothers.

REGULATING AMMONIA LIQUOR STRENGTH

ON the editorial page of Feb. 1 Practical Engineer, appears the statement "When a weaker solution of aqua ammonia than the standard 26 deg. Baume is desired for charging an absorbtion machine it is the practice to add water, and if a stronger solution is desired to add anhydrous, and there is no reason for drawing weak liquor for any purpose."

As a metter of fact no experienced engineer will prefer a weaker liquor than 26 deg. Baume for the generator at any time, and much prefer 28 deg., because it requires less heat to liberate the anhydrous gas, and also because under the operation of the machine it will be weakened more or less by reason of imperceptible leaks.

The method mentioned for strengthening the weak liquor is correct, but if there is already a full charge in the system, no more can be added until the proper proportion of weak liquor is withdrawn, and in order to save the anhydrous contained in the weak liquor, distillation must be resorted to, and the quantity to be withdrawn by distillation in order to bring the balance up to standard can be readily ascertained by refering to the standard tables and calculating the quantity. Wm. S. Luckenbach.

WHY?

I HAVE seen much written by practical men about safety of operating, and license of engineers in charge of them. Why is it that it is called for in stationary plants only, when there are boilers of different sizes allowed to be run by anybody, anywhere, and are not worked in one place long at a time? I refer to such boilers as used on street rollers and concrete mixers, hoisting engines, etc. They are often operated on streets

where thousands of people are passing and repassing, by men who hardly know an engine from a wheelbarrow, and there is nothing said.

I know of 3 concrete mixers and 2 street rollers that are in charge of a man in this state who doesn't think that it is necessary to open a boiler and wash it out; all of the fittings get charged up with mud, and these boilers have never been inspected, according to his own story. One of the rollers has been in service 3 yr., and the plates have never been out of the heads to allow inspction inside of the boiler. But he knows all about a boiler and can't be told anything. He is the head engineer for this company, but anybody that knows anything about a boiler can see that the boiler is unsafe for anybody to handle.

Why is it that these boilers are not looked after as well as those in power plants? I think that they are as dangerous in the hands of an inexperienced man as a stationary boiler. Why doesn't the State of Ohio examine and license these engineers too? I would like to hear from the readers of Practical Engineer.

J. E. Jones.

HOLE WORN IN BOILER TUBE

A BOILER maker walked into our engine room the other day and showed us a piece of boiler tube which he had just cut off a tube he had replaced in a vertical fire tube boiler. The tube had a hole in it caused by the feed pipe rubbing against it. This is how it happened. The feed pipe entered the boiler and ran across to the other side, between the nests of tubes, and was fastened at the end by fitting over a pin riveted in the shell. One day the engineer took out the feed pipe to examine it and when he replaced it, neglected to fit it over the pin. The consequence was that the action of the pump caused the feed pipe to rub against an adjacent tube and wore a hole in it. If I remember rightly, the boiler maker told us that it took something like 3 months to cause the tube to leak.

Frederick M. Perras.

LUBRICATOR IMPROVEMENT

MR. McGERRY, in his letter in the Jan. 15 issue, does not do justice to the "lubricator improvement," which the writer also described in an article in Popular Mechanics some time ago, and I feel that its value to the engineer warrants a few more words of explanation.

Mr. McGerry says (using his lettering as reference): —"To fill the lubricator, close the valve G, open D, and plug X, and pump the oil from A into the lubricator H." By such procedure he has gained little or nothing over pouring the oil manually. By opening the valve D, however (leaving the plug X closed), and operating the pump, the oil is forced in on top of the water, which in turn is forced up through the condensation riser and passes off to the engine cylinder with the steam; a fraction of a cubic inch of water being sent over with each stroke of the pump.

The operation of the lubricator is not arrested during the filling operation, and the riser pipe being left full of water, the oil continues to feed without change of adjustment. The draining of the lubricator is a superfluous operation.

Lee Boyer.

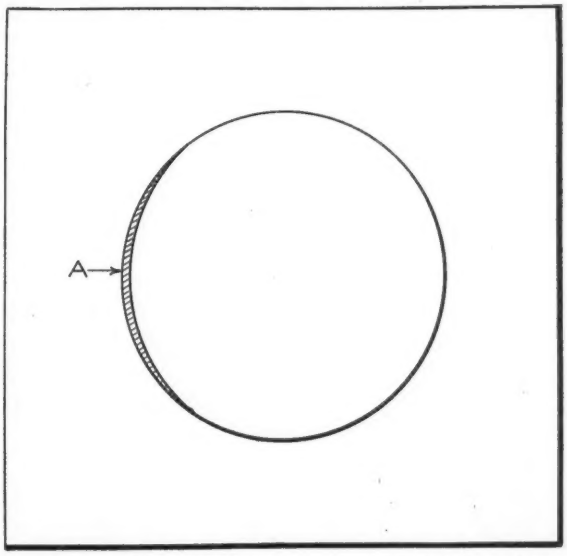
FILLING THE LUBRICATOR

REFERRING to the article in the Jan. 15th issue, by Martin McGerry, on a Lubricator Improvement, I have used this scheme for over a year and find that it is not necessary to stop or drain the lubricator in order to fill it. Simply pump oil in and the water will run back into the steam line.

E. H. Spooner.

THE CRANKPIN

DURING the experience of the average engineer there is no piece of apparatus that requires more care and receives more abuse than the crankpin. Crankpins wear most when the pressure is the greatest and where the sliding speed is the highest, that is to say, where there is the most friction. This sliding velocity is almost constant, so this sliding velocity or pressure on the pin governs the wear, more or less, of course, as this pressure becomes greater or lesser and causes flat spots to appear on the pin. These flat spots, however, appear only on one side of the pin, unless the engine is a reversible one and runs with a load in either direction. The point at which wear occurs most and at which there is most likely to occur a flat, is at A in the cut, the shaded portion being worn off on a horizontal engine for about ¼ stroke.



CROSS SECTION OF CRANKPIN SHOWING POINT OF MOST WEAR

Of course there is some wear all around, the weight of the crank end of the connecting rod has to be borne all around the circumference of the pin and there is a little wear from that, also from the expansion of steam in the cylinder there is some work performed; if it were not so there would be no use for a variable cutoff engine, but the most wear will occur from the point of admission to the point of cutoff, as the pressure on the pin is greater at this point and diminishes correspondingly to the point of release as to the amount of expansion obtained. Owing to this fact, some engineers make a mistake when keying up which often gives them a good deal of trouble. The best place to have a pin for keying up is at the point where the compression begins a little before on either stroke.

If the keying up were done on a horizontal engine just over the center in the direction the engine runs it would be made at the smallest part of the pin at a point where the pressure is greatest and consequently where a flat spot on the pin would most likely be, and if keyed up at this point, when the crank had made a quarter turn the brasses would bind on the pin, thus causing undue friction and consequently heating.

Of course on an engine that is not very old and has received best of care, this amount of flat will be very

small, and yet a good many engineers would be surprised at the variation if they were to caliper their crankpins closely. In view of this fact, it is therefore a great deal better to set up the brasses at the wide part of the pin, as they may be set up pretty snug then, not to bind, of course; but if they were loose at the large diameter they will be still looser at the point of small diameter, and a pound or thump louder than might be expected will be the result.

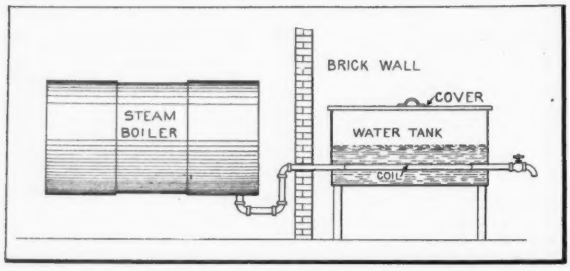
Then there is no question that a good deal of lost motion can be taken care of by compression, but an engine whose boxes and pins are in poor condition and which require an excessive compression, is not running as economically as it should, and the remedy to insure quiet running should be applied at the right place, viz., the pins and boxes. Of course a small amount of compression is necessary, but an engine whose pins and boxes are in good condition will run quietly and economically with a fair load if the valves are set properly and a small amount of compression will be necessary.

Chas. H. Taylor.

AN ENGINEERING MIXTURE

How All Around Knowledge was Acquired by One Engineer

ABOUT 23 years ago I started in to fire and labor (mostly) for a man who operated a grist mill, saw mill and farm and also ran a dairy. I was wildly enthusiastic with the glory of being a ready-made engineer and was willing to help in all quarters, before, after and between engine running for the privilege.



ARRANGEMENT FOR WATER HEATING TANK

In the day's work my first duty was to light the fire, in the house, not under the boiler, at 5 a. m.; then help to feed the animals and clean around the stable, get breakfast and get up steam on the 14 ft. by 60 in. return tubular boiler by 7 o'clock. Morning hours brought odd jobs about the mill in the intervals of shoveling sawdust, chucking slabs and oiling up. Then at noon-time came the hurried meal in order to get time to help wash milk cans and to get started at 1 p. m.

When any very heavy chore came up, the boss sometimes sent his wife to look after the boiler and engine, which was about 12 by 20 in. slide valve, and I helped with the heavy lifting.

Boiler feeding was accomplished by a geared power pump and an injector had been provided for a reserve, but at some time the pipe had been frozen and split and the boss had filled the split with pine wedges to prevent water running out. As this did not appear to help any, he had fallen back on the pump and everything went lovely as long as the pump kept on going. Of course, I did not know; at that time, why the injector would not lift the water so could not fix it.

The boiler had been in use for some years, and I think had never been cleaned out; at any rate it was never cleaned while I was there, and I did not know that a boiler could be cleaned. If Josiah Green or Hezekiah Brown came with a load of wheat, I generally left the boiler and engine to look out for themselves and helped unload and weigh out the grain; sometimes I left things too long and the machinery would stop. Then bearings and boiler got hot and also the language and the atmosphere became heated.

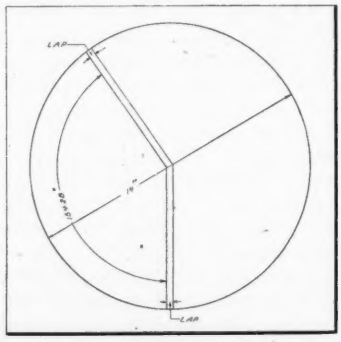
One peculiar, and I am sure original, arrangement which was actually in use and probably is yet, if the plant has not been blown sky high, is shown in the illustration. A pipe was connected to the blowoff outlet and run through a tank of water, and all water needed to wash milk cans and for similar uses was drawn off through the blowoff outlet, thus heating the clean water in the tank which was used for cooking and other household purposes; and understand that this draw off cock, which was connected to the blowoff, was in a separate room from the boiler with a solid brick wall between, so that the engineer never knew when the cock was open.

There were many other original ideas of a similar kind at the plant and I nearly got discouraged and was seriously thinking of giving up being an engineer at this time, as my working hours were from 14 to 16 a day for $16 and board a month. Thank the fates I had a row with the boss shortly and quit, and soon after secured a job as fireman in a real plant, which was my first step toward learning my profession. But after 23 years I can find plants just as far behind the times and operated just as carelessly as was the one where I got my first initiation.

H. B.

LAYING OUT PATTERNS FOR CONICAL SURFACES

OCCASIONALLY engineers have to do a little sheet-metal work, and sometimes the laying out of a pattern for a conical surface is required. The laying out of the pattern is very simple; but with any of the methods that I have seen in books on sheet-metal work



METHOD OF LAYING OUT A CONICAL SURFACE

it is difficult to determine the exact amount to cut out of the circle from which the pattern is cut, so that the cone will be just the required diameter.

For determining the number of degrees required out of the circle from which the pattern is cut, I have worked out the simple formula given below, which I have found very accurate as well as a time-saver:

Let d = diameter (base of cone).

D = diameter of circle from which pattern is to be cut.

n = number of degrees in that part of the circle required for the pattern.

Then we have:

$$n = \frac{360d}{D}$$

Example:—It is required to lay out a pattern for a cone whose base is 6 in. and its slant height 7 in. The diameter of the circle from which we cut the pattern will of course be twice the slant height of the cone, or $2 \times 7 = 14$ in.

Applying the formula we have:

$$n = \frac{360d}{D} = \frac{360 \times 6}{14} = 154.28 \text{ deg.}$$

This with the lap added will make the cone exactly the size required. Try it.

Chas. O. Hagen.

BLOWOFF ARRANGEMENT AND BOILER CLEANING

WITH all due respect for Mr. Hawkins' opinion of Charles H. Taylor's blowoff pipe arrangement. I for one can't see where it has any advantage over the rear end blowoff, as regards safety of the fireman, or boilers, or pipe.

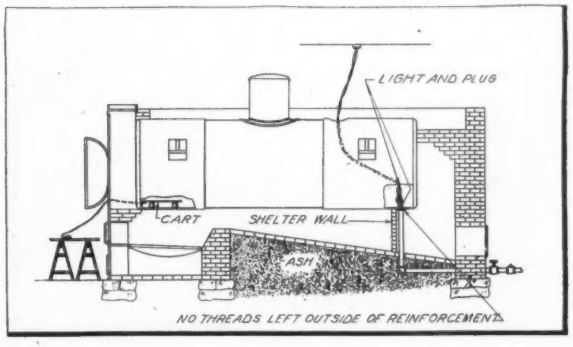
Mr. Taylor's arrangement puts the reinforcement on the boiler, a short nipple and an ell, in a very hot place, where they come in contact with the hot gases before the water filled boiler has a chance to take any of the heat out, as in the case of the rear blowoff. Then Mr. Hawkins complicates matters by putting another hole in the boiler sheet, with a reinforcement, a short nipple and an ell, all below the fire line. Who ever heard tell of a boiler being burned or bulged on the sheet close to the front head? I have never had one bulge on me, but bulges I have seen in every instance occur directly over or a little beyond the bridge wall, or just back of the first girth seam and were caused by circulating water carrying mud, oil or scale along the bottom of the boiler until stopped by the rivets of the girth seam; there they pile up and prevent the water from coming in contact with the sheet until it becomes hot enough to be plastic. Then pressure forces the soft metal towards the fire and a bulge is the consequence.

The majority of boilers make more scale at the back than they do in any other place, because that is where the feed water is dumped into them and any one looking at Mr. Taylor's sketch can see that he is tempting fate by trying to draw scale from the back to the front of the boiler over the girth seams, and if he doesn't get a bulge at the girth seams he will surely get it at or around his blowoff, where that pile of scale is seen marked X in his sketch. The blowoff either at the front or back will remove slush, mud, and possibly a little light scale that is in its immediate vicinity. But as a scale ejector it is not what some engineers would have one believe. This can be proved by any of the engineers who blow their boilers out on the surface of the earth. Just erect a partition about 3 or 4 ft. from the end of blowoff and after blowing down the boilers, twice a day for a month, one can carry all the scale he gets back to the boiler house in one hat, and the more scale in his boilers, the less he will get.

If Mr. Taylor or Mr. Hawkins was ever in a boiler room when a blowoff pipe let go I wager he wished that the scene of the disturbance was further away than the length of a boiler, and would thank his lucky stars that tht blowoff was not in the front.

Here is the arrangement of the blowoff in the plant where I am employed and I think it will interest engineers to know that it has been in service night and day for 7 years without an accident or renewal of pipes. The only change in the system since instalment was the inserting of a gate valve between the boiler and blowoff cock.

Our water is taken from the Hoosac river and is pretty dirty. We blow down a little every 4 hr., but we dont depend on that to keep our boilers clean. Every boiler is opened once a month and all scale removed through the man hole in the front head, as the back head has got no opening. We use a little cart as shown by the sketch after all loose scale is washed and knocked from the back head and between the tubes. The cart is placed inside the boiler and the man who does the cleaning crawls in and lays breast down on the cart and propels himself with his hands to the back head where he collects all the scale and mud and then gives the signal and the men on the outside pull the cart with a rope very slowly while



BLOWOFF PIPE ARRANGEMENT AND BOILER CLEANING APPLIANCES

the man on the wagon scrapes the scale along till it can be reached from the outside, then a hose is inserted and the boiler is washed out.

Then all the scale is removed with a hoe through the man hole and the wagon again put in and the man once more goes in and removes his light, which is fastened to a plug that he inserted into the blow-off pipe when he first went in.

Every time we clean our boilers we paint the blowoff pipe with a mixture of graphite and cylinder oil, after removing all dirt. One thing we don't do is put cold water into a boiler, whether cold or hot, so we avoid the dampness of which Mr. Hawkins speaks.

John E. Kimbsley.

CAUSE OF GRINDING GEARS

GRINDING of automobile gears is generally caused by speeding the motor too fast on the low gear. So that the clutch has too much momentum, and when the low speed is disengaged, the teeth on the intermediate gear have to arrest this speed before the gears can be meshed, in changing to that speed. In changing from the low speed to the intermediate, the motor should be run at a normal speed, and just the instant that the clutch is thrown, it would be a good idea to close the throttle slightly, then change the gears with as quick a movement as possible. If the gears still grind the trouble is in the clutch, which will be found to drag, and can be easily remedied. F. H. Bliven.

NOTHING IN the world undermines one man's confidence in another so decisively and quickly as to hear that he is slow about meeting little obligations.—Mahin Messenger.

SUCCESSFUL KINKS

FOR SAVING TIME, WORK AND TROUBLE

A Home-Made Help

OUR equipment includes two of the older type Butman upright boilers with the water column piping and valves set back about 2½ ft. from the front of the supporting brickwork. If a valve was to be operated we had to use a ladder to reach it. On account of the projecting brickwork we were unable to use ordinary pull chains on the valves, so hit upon the idea of using a long rod with a valve wheel on one end and a knuckle joint on the other. This allowed us to stand on the floor while operating valves—especially convenient in the case of the blow down valves. The sketch will explain how we arranged this appliance.

We shaped a strip of flat iron, as shown in Fig. 1, drilling a small hole in each end and drilling and tapping a hole in its middle, as shown at A. The strip was then bent at right angles along the dotted lines B. The rod was, in our case, about 4 ft. long and ⅜ in. in diameter. This we threaded on one end and screwed into the hole A, and added a nut on the end of rod as a lock, as shown at D. The opposite end of rod was filed square and fitted into a wheel from an old valve, the outer end being upset with a poening hammer so that the wheel was secure. A circular piece of iron slightly less in diameter than the distance between the legs of the fork and about ⅜ in. thick was drilled at 90 deg. intervals, as shown, and these holes bottom tapped. We used a 3/16-in. drill. This was secured between the prongs of the fork by passing top bolts through holes in the latter and bottoming them tight in the holes in the circular disk, as shown at E.

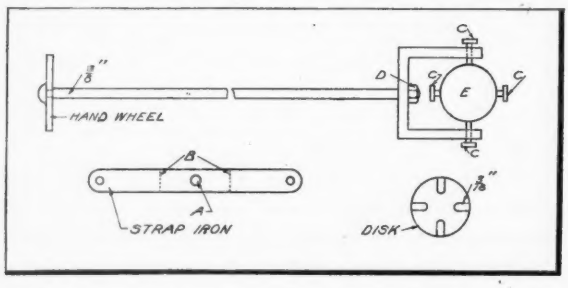


FIG. 1. DETAILS OF UNIVERSAL JOINT FOR OPERATING VALVES

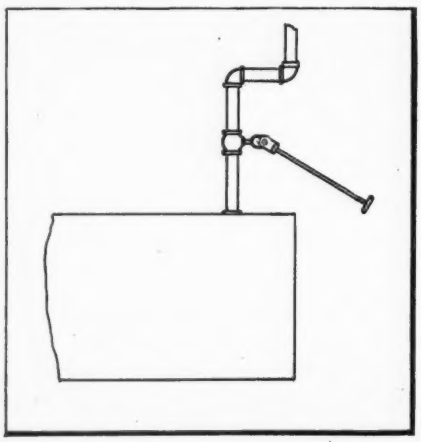


FIG. 2. APPLIANCE ATTACHED TO ENGINE VALVE

Another fork exactly similar to that shown was made, except that central hole A was made square and driven on to stem of the valve to be operated and there fastened by upsetting the end of valve stem. Tap bolts were used to secure this fork to the disk and as before securely bottomed. These 2 forks and disk form a very simple and efficient universal joint, and if the tap bolts turn easily in the fork holes, very little binding results. By the use of this appliance we were saved much ladder climbing, as the hand wheel on the rod was within easy reach from the floor. The sketch, Fig. 2, will give a general idea of arrangement.

V. E. J.

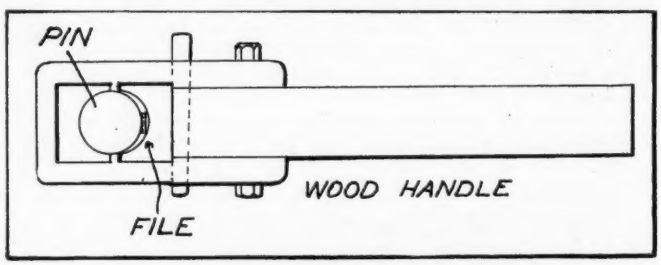
Truing a Crank Pin

SOME time ago I received a small engine which was to be used temporarily for about 3 months to "help out" a large unit.

The repairs progressed exceedingly well, considering the machinery we had with which to make repairs, until we came to the crank pin, which upon calipering was found to be a little small in one place.

As we had very little time in which to complete repairs and get the engine in service I conceived the following plan to true up the pin without taking it out of the crank disk:

Disconnect the engine, using the strap and brasses as a tool. Take a piece of wood about 18 in. long and as wide as the strap, bore a hole in one end and insert a piece of broom handle for a handle. Bore a hole in the other end to pass the strap bolt through with ease. Take a flat smooth file about 1¼ in. wide, break it off at both ends so that the piece will be a little longer than the pin, grind the ends square and to the same length as the pin. Smooth off the rough edges of the beards a little by rubbing it on an oil stone so that each beard of the file will be a cutting edge.



METHOD OF TRUING A CRANK PIN

Slip the back brass away from the pin so as to allow the file to enter lengthwise with the pin. Make a wooden key narrow enough to fit into the key slot. Use the arrangement as a crank by turning it around the pin, occasionally give the key a slight tap and a drop of oil. After the pin is round take out the file and insert a piece of emery cloth and a few drops of oil will make a pin as good as new.

Russell R. Ux.

Kinks From the Day's Work

THE first sketch shows an oil feeder and regulating gage which was designed for a plant to do away with the constant filling of lubricators and oil pumps. The reservoir consists of a section of iron pipe 6 in. diameter by 18 in. long, capped on the ends and having tapped into the lower cap a line leading to the live

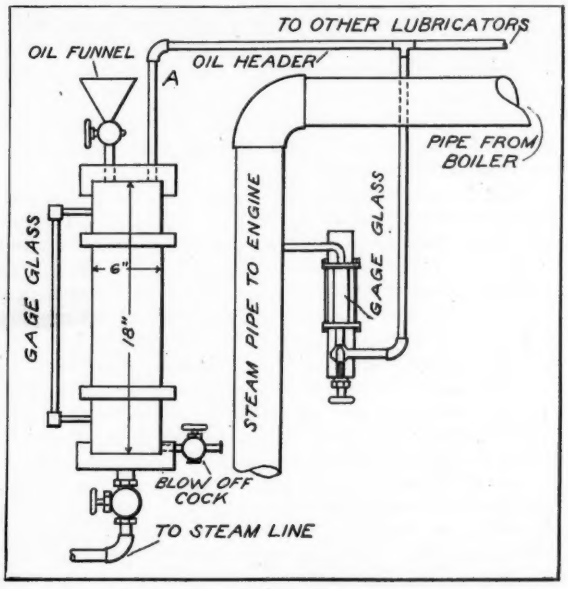


FIG. 1. AN OILING SYSTEM FOR STEAM CYLINDERS

steam line, with a valve, and from the side of the pipe near the bottom a blow-off cock. A gage glass was fitted to the section of pipe to show the height of oil in the reservoir, and from the top cap was led an oil header for distributing the oil to the different lubricating devices. Also into the top cap was led a filling pipe with valve and funnel.

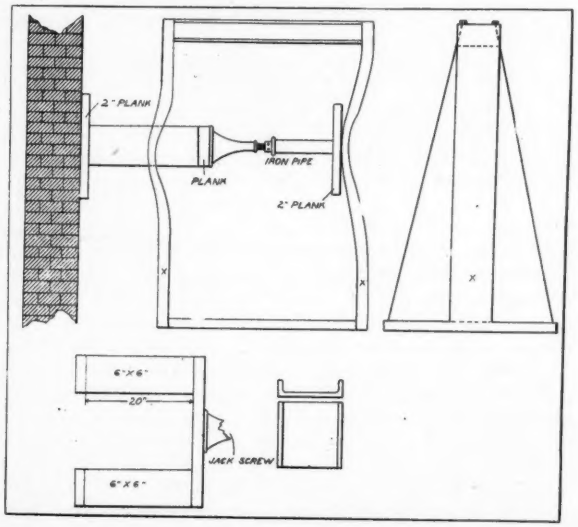


FIG. 2. STRAIGHTENING AN ELEVATOR FRAME WITH A JACK

At each machine where oil is to be delivered, a branch is taken from the oil header and carried to a needle valve through which the oil passes to a sight feed glass and thence to the steam pipe. The method of operating the system is obvious without comment.

In the illustrations, Figs. 2 and 3, are shown the methods employed for straightening the 2 sides of an elevator car which were bent in an effort of said elevator to get through the roof. The bend in one was taken out by the use of a jack screw and blocking from the wall of the elevator shaft and for the other one, where the space was too short to get a jack on the

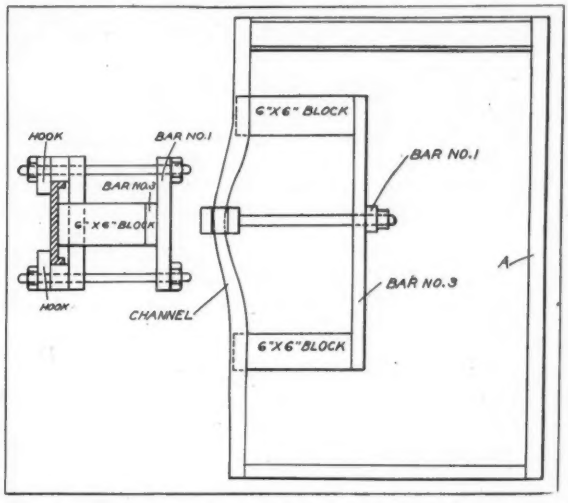


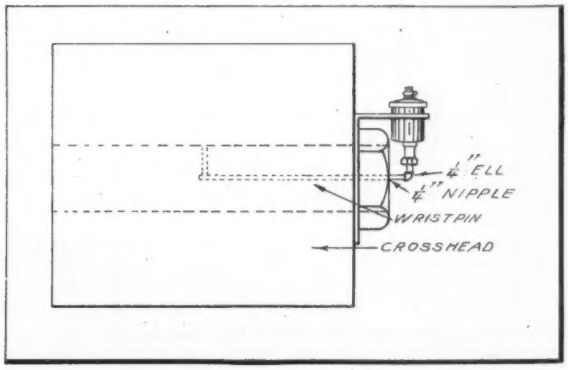
FIG. 3. A PULLING RIG FOR STRAIGHTENING A BENT ELEVATOR FRAME

side of the elevator, a pair of heavy bolts were made, and by means of steel bars and blocking, a pull was secured to line it back to its original position. The dimensions of the different parts used are given, the time for the job was 5.5 hr., which was something of a saving against the estimated cost of $25 for straightening.

A. Wiedenbauer.

Crosshead Grease Cup Holder

THIS is made by taking a piece of sheet brass or iron, about 4 in. long by 2 in. wide, drilling a hole in one end large enough to fit the wristpin, and one for the



HOLDER FOR GREASE CUP ON CROSSHEAD

grease cup in the other, then bend to an angle of 90 deg., place it on the wristpin and tighten the nut down.

Wm. Carpenter.

CONCENTRATE your thought and energy on the weak parts of the plant if you desire maximum efficiency.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

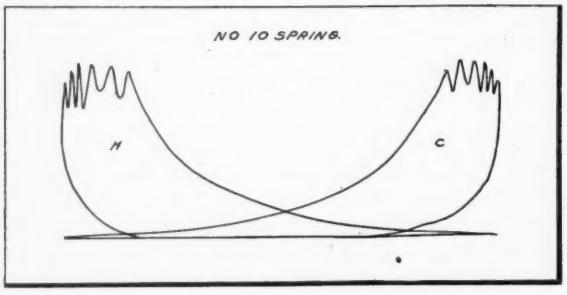
Air Compressor Card for Criticism

ENCLOSED is an indicator diagram of air compressor. It is 11 by 36 in. tandem compressor connected to a Corliss engine; admission valves are of the Corliss type. I wish the diagram criticised and want to know what should be done in order to make it approach a theoretical card. T. Jones.

Manning Boiler Problem

IN a Manning boiler using forced draft how far would the flames from the fire go up into the tubes? J. W. D.

A. This question can not be definitely answered, as the exact conditions of fire, draft, and percentage of



AIR COMPRESSOR CARD FOR CRITICISM

boiler capacity obtained are not given, and even though they were, it is a question which could be answered only experimentally. The following consideration, however, may be of interest. Ignition can take place only in the presence of oxygen, with the gases at a sufficiently high temperature. If either one is lacking, then we have no flame. It is conceivable that with a high enough velocity of gases a sufficient supply of oxygen, a water temperature of 350 deg. surrounding the tubes and a flame entering at approximately 1800 deg. F., that the gases would not be cooled below the point of ignition, and that the flames would follow through the entire length of the tubes, leaving at a temperature of perhaps 1000 or 1100 deg. F. In the actual operation of the boiler, we would hope to have the escaping gases down to 500 deg. or perhaps less. As the temperature of the flame probably ranges from 900 to 1500 deg., with an average of about 1100 deg., we would expect combustion to be entirely completed before having traveled many inches in the tube, the probability being that the best efficiency would be achieved with the combustion completed before the flame enters the tubes.

Flow of Steam Through Pipes

HOW many pounds of steam per minute at 60 lb. gage pressure will flow through the following sizes of steam pipe; 1¼ in., 1 in., ¾ in., ½ in. and ⅜ inch. A. F.

Ans. This depends on the size of pipe, the length of pipe, amount of drop in pressure between the two ends and the initial pressure.

The best treatment of this subject is given in a paper presented by Prof. R. C. Carpenter before the American Society of Mechanical Engineers, in which he gives a table for the flow through 100 ft. of pipe at 100 lb. absolute pressure and for 1 lb. drop in pressure. Under these conditions the flow through a 1¼ inch pipe is 4.88 lb. per minute, through a 1-in. pipe 2.20 lb., ¾-in. 1.10 lb., ½-in. 0.75 lb., and ⅜-in. 0.40 lb. The last two values are estimated by means of a curve, as they are not given in his table.

He gives also a diagram showing a correction factor at 75 lb. boiler pressure, 0.87. Multiplying this in, we get that for a 100 ft. length pipe, 1 lb. drop in pressure and steam initially at 60 lb. gage or 75 lb. absolute, the pounds per minute flow would be:

For 1¼ in. pipe, 4.25 lb.
For 1 in. pipe, 1.915 lb.
For ¾ in. pipe, 0.957 lb.
For ½ in. pipe, 0.653 lb.
For ⅜ in. pipe, 0.348 lb.

If the flow is through a short piece of pipe direct to atmosphere, the amount of flow would be approximately that through an orifice.

The rule for this is to multiply the pressure in pounds absolute by the area in square inches and divide by 70. This gives the flow in pounds per second through the orifice, the rule being good for pressures over 30 lb. absolute.

2. There seems to be a wide difference as to rules regarding rate of flow of steam through pipes. Prof. Carpenter's tables give for 1¼-in. pipe, 4.25 lb. per min.; 1 in. 1.915 lb., ¾ in. .957 lb., ½ in. .653 lb., and ⅜ in. .348 lb., while the rule given which corresponds with Napiers gives for 1¼ in. pipe 78 lb. per min.; 1 in. 50.4 lb., ¾ in. 28.4 lb., ½ in. 12.6 lb. and ⅜ in. 7.098 lb. Prof. Carpenter's rule seems low and Napiers rule seems high. We have quite a number of different pressure. The steam is discharged as it would be through an orifice. I would like to get some rule for estimating approximately the amount used. The pipes run from ⅜ to 2 in. in size.

Ans. The difference between Carpenter's figures and those from Napier's formula is due to the fact that Napier provides for flow direct into the air with full drop from the initial pressure to atmospheric pressure, while Carpenter's figures are for flow through 100 ft. of pipe with a drop of only 1 lb. in pressure, i.e., the pressure at the end of the pipe is only 1 lb. less than that at the inlet.

We have run through the computation for the flow according to Napier's rule and cannot quite make our figures agree with yours. For instance, for 1¼-inch pipe at 60 lb. gage, which would be 75 lb. absolute, we get 90 lb. per minute flow; for 1-in. pipe 55.3 lb.;

for ¾-in. 34.1 lb.; for ½-in. 19.3 lb.; for ⅜-in. 12.2 lb.

It may be that this comes from taking the actual internal area of the pipe instead of the area of the circle corresponding to the diameter. You know, of course, that the area for 1¼-in. pipe is 1.4 sq. in., whereas the area for a 1¼-in. circle is 1.23 sq. in.

In regard to the flow under the conditions that you mention, the only thing that we know of which gives this value where the pressure at the outlet is not atmospheric pressure is a table by D. K. Clark which happens to fit your conditions. He gives that for an absolute pressure of 75 lb. at the inlet and external pressures as given below, the discharge per square inch of orifice area in pounds per minute will be as shown:

For	74	lb.	outlet	pressure,	16.68	lb.	per	minute.
"	72	"	"	"	28.35	"	"	"
"	70	"	"	"	35.93	"	"	"
"	65	"	"	"	48.38	"	"	"
"	60	"	"	"	56.12	"	"	"
"	50	"	"	"	64.00	"	"	"
"	45	"	"	"	65.23	"	"	"
"	43.5	"	"	"	65.3	"	"	"

And the same overflow for all pressures lower. This table is from a series of experiments conducted by Brownlee, who found that where the outlet pressure is less than 58 per cent of the inlet pressure the flow is constant at the value given for the 43.5 lb. pressure.

Suplee states that the outflow from one pressure to another increases as the increase in difference of pressure down to the 58 per cent point, but Clark gives no formula or method of computing the outflow. We have figured the outflow for the sizes of pipe that you mention, considering the external pressure as 74 lb. We find that

For	1¼	-in.	this	will	be	22.4	lb.	per minute.
"	1	"	"	"	"	14.4	"	" "
"	¾	"	"	"	"	8.85	"	" "
"	½	"	"	"	"	5.02	"	" "
"	⅜	"	"	"	"	3.17	"	" "

Of course, if your drop in pressure is more than one pound from inlet to outlet, you would have to figure accordingly. We used here the figure 16.68 lb. per minute per square inch of area as given above.

Some Ohio Examination Questions and Their Answers

A CORLISS engine that cuts off at ¼ stroke is stopped with the piston at the middle point of its travel and consequently with both steam valves closed.

What is to be done?

Ans. Unhook the wristplate from reach rod and work the valves by hand by using the starting bar. If the engine is on the top quarter and is running over, open the head end steam valve. If the engine is on the bottom quarter, open the crankend steam valve. If the engine runs under, just reverse the operation.

2. How would you determine whether the center line of the crank pin is parallel to the center line of the shaft?

Ans. Drop a plump bob from the ceiling or the top of the crank disk the shorter the line the better. See that this line passes through the center of the shaft. Now place the engine so that the crank pin is on the bottom quarter and the line cuts the center of the pin. Now scribe a line with a straight edge from the center of the pin, across the end, Fig. 1. Turn the pin to top quarter and if the plumb line centers on this line and passes through the center of the shaft, your crankpin is parallel to the shaft, Fig. 2.

3. Why is it desirable to maintain the pressure in a boiler as uniform as possible?

Ans. Allowing the pressure to fluctuate back and forth keeps the boiler expanding and contracting continually and for every change in pressure there is a corresponding change in temperature; this action therefore shortens the life of the boiler. Allowing the pressure to drop necessitates rapid firing and therefore a loss of coal and more work for the fireman, and when the pressure is allowed to get too high, the safety valve blows and you are blowing steam at boiler pressure into the atmosphere and therefore wasting coal.

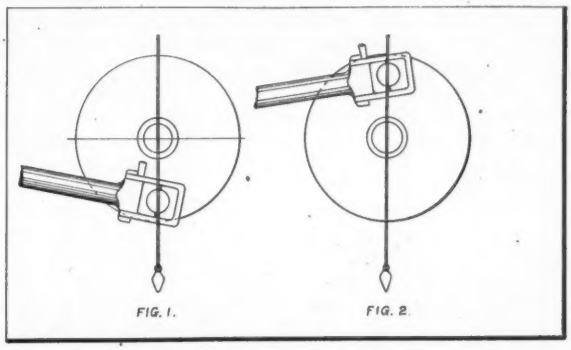


FIG. 1. CRANKPIN ON BOTTOM QUARTER TO MAKE SCRIBE MARK

FIG. 2. CRANKPIN AT TOP QUARTER TO TEST SCRIBE MARK TO PLUMB LINE

4. What effect has the clearance on the mean effective pressure ?

Ans. Suppose that the clearance is 5 per cent or 0.05 of the whole stroke, and the cutoff takes place at ¼ stroke, the ratio of expansion is then $(1 + 0.05) \div (0.25 + 0.05) = 3.5$.

Without clearance the ratio of expansion would be, $1 \div 0.25 = 4$; hence. the expansion line, and therefore the mean effective pressure will be higher with clearance than without; the larger the clearance, the greater will be the m. e. p. John J. Mahoney.

Crosshead Travel

WILL you kindly send me a rule for finding out how far a crosshead has traveled, when the crank is on half stroke? B. B.

A. The easiest way to find how far the crosshead has traveled when the crank is at ½ stroke is to lay

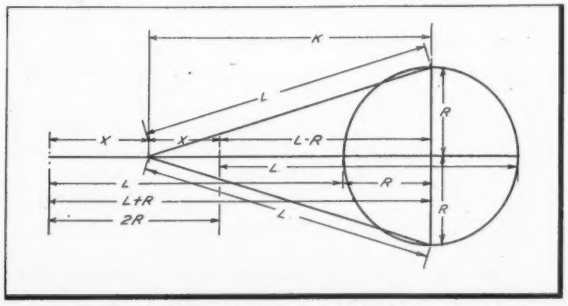


DIAGRAM EXPLAINING CROSSHEAD TRAVEL

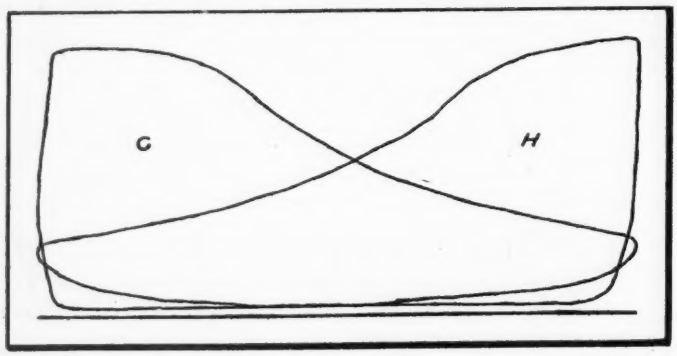
out a diagram to scale, showing the crank circle and the center line and the crosshead travel. Then place the crank head at dead center, measure off from its position the length of the connecting rod and it gives you the position of the crosshead at the end of the stroke.

Suppose that the crank has moved up to the 90 deg. point, which will be ½ stroke for the crank, measure from this with the length of the connecting rod, and where it strikes the center line will be the new position of the crosshead. The distance between the two positions measured to scale will give you the distance traveled by the crosshead. This will be different for the two strokes forward and back.

It is possible to figure out this value by arithmetic as follows:

The distance from the shaft center to crosshead when the crank is on head end center will be L + R, where L is connecting rod length and R is crank length. When the crank has turned to the 90 deg. point, the distance from crosshead to the center of the shaft will be the base of a right-angle triangle. The vertical side will be R and the hypothenuse L. The length of this base is found by squaring L, squaring R, then subtract the square of R from the square of L, and extract the square root of the remainder.

This will give us the distance K from crosshead to shaft center. If we subtract this distance K from the distance L + R, it will give us the distance that the crosshead has moved. If we start from the crank end dead point, the distance from the shaft center to the crosshead will be L — R. When the crank has progressed to its 90 deg. position, as you will see by the drawing, the crosshead will be at the same position as



DIAGRAMS FROM AN OLD ENGLISH ENGINE AFTER 50 YEARS' SERVICE

before when the crank is at ½ stroke, but the distance that the crosshead has moved from the end of the stroke will be less than in the first case, and will be found by subtracting the value L — R from the base of the triangle as previously found.

Cards from Old English Engine

ACCOMPANYING indicator diagrams were taken from a slide valve with auxiliary cutoff, double eccentric, trottling governor engine built in England and came around Cape Horn to Oakland, Cal., almost 50 yr. ago. It has been in constant use all these years, and in the 8 yr. which I have been with it the repair bill has been practically nothing and it is running 10 hr. of every day. From the planimeter what is the horsepower of these diagrams and what changes might be made to get a better card?

The engine is 12¾ in. diameter by 42 in. stroke running at 78 r.p.m. and under 80 lb. boiler pressure. The spring used for the diagrams was 40 scale.

A. E. B.

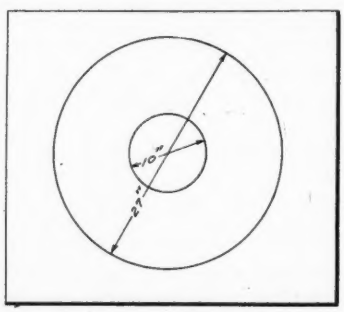
A. The cards from your engine are very interesting and show fairly good steam distribution. It appears, however, that most of the events come a little late for the best operation. The crank end admission is a little slow, which is indicated by a lagging admission line. It would appear also that the cutoff comes a little late giving release pressure too high for most economical operation. The release on this end of the cylinder comes very nearly at the end of the stroke, so that the back pressure at the beginning of the return stroke is more than it should be. Compression of this end of the cylinder is about right, but, as other events are late, it would be necessary, probably, to have this come earlier in the stroke.

The head end card is better in regard to compression, admission and cutoff, but release is too late also in this end of the cylinder, causing large back pressure.

In regard to the horsepower developed, the planimeter shows the crank end to have mean effective pressure 37.1, head end 36.43 lb. The average of these 2 would give us 36.77 and using this in the formula for horsepower we obtain $36.77 \times 3.5 \times 127.68 \times 78 \times 2 \div 33{,}000$ gives according to the slide rule, 77.5 horsepower.

Bolts for Follower Plate

THE diameter of the high-pressure cylinder is 27⅛ in., and the follower plate is 27 in. diameter and is cut out in the center 10 in., where it is a snug fit on the spider. The follower is of steel, 1 in. thick, and the



DIMENSIONS OF FOLLOWER PLATE

bull ring has 2 snap rings and an Allan metal center. Kindly let me know how many follower bolts are required, what size these bolts should be, and what factor of safety is required for this work. B. J. T.

A. In designing a follower for a piston it is necessary to have the follower of sufficient thickness to be perfectly rigid under all ordinary operating conditions. It is usual to use follower bolts of a size and number which will withstand boiler pressure with the bolts in tension, using a factor of safety of 6.

The diameter of the follower is 27 in. and the hole in the center is 10 inches. Then the effective area would be $(27^2 \times 0.7854) - (10^2 \times 0.7854)$ which would give 494 or approximately 500 sq. in., subject to boiler pressure of 135 lb.

Then $135 \times 500 = 67{,}500$ pounds pressure on the follower bolts in tension. Assume that for the bolts we use a good grade of machine steel with a tensile strength of 60,000 lb. For a piston of that size 8 bolts would be ample, which would give 8435 lb. strain on each bolt, and using 6 as a factor of safety, 6×8435 would give 50,610 lb. Then $\frac{50610}{60000} = 0.8435$ as the area of the bolt at the base of the thread, which just about corresponds with a 1¼-inch bolt which has an

area of 0.893 sq. in. at the base of thread. Therefore, 8 1¼-in. follower bolts would be ample.

G. H. Wallace.

Boiler Heating Surface and Engine Horsepower

WHAT is the heating surface for a boiler 72 in. diameter, 18 ft. long, and having 60 4-in. tubes; use ½ of the shell and no head surface in making the calculation.

2. An engine is 22 by 48 in., running at 70 r.p.m. The mean effective pressure is not given. What is the horsepower of the engine? H. H.

A. The circumference of a 72-in. boiler shell is 226.2 in., half of which would be 113.1 in. or 9.4 feet. The shell is 18 ft. long, then $18 \times 9.4 = 169.2$ sq. ft. of heating surface in the shell.

The circumference of a 4-in. tube is 12.56 in. or 1.047 ft. There are 60 tubes, each 18 ft. long. Then $18 \times 60 \times 1.047 = 1081$ sq. ft. of heating surface in tubes, and $1081 + 169.2 = 1250.2$ sq. ft. of heating surface.

2. In an engine 22 by 48 in. running 70 r.p.m., when the steam pressure and point of cutoff are not given, we will assume them. Suppose the initial pressure is 125 lb. and the cutoff takes place at 1/5 stroke, also 1 pound back pressure. Then the ratio of expansion will be 5. We find by referring to a table that the hyperbolic logarithm of 5 is 1.6094. Then to secure the m.e.p. use the formula:

$$\frac{(HL + 1) \times P}{R} - B = M.E.P.$$

HL = Hyperbolic Logarithm of ratio of expansion.
P = Initial pressure absolute (gage + 14.7).
R = Ratio of Expansion.
M.E.P. = Mean effective pressure.
B = Back pressure above a vacuum.

Substituting figures in the formula, we have:

$$\frac{2.6094 \times 139.7}{5} - 15.7 = 57.2, \text{ M.E.P.}$$

No allowance has been made for clearance as the question does not state it. Having secured the M.E.P., the horsepower is found by the formula:

$$\frac{\text{PLAN}}{33{,}000}$$

in which:

P = Mean effective pressure.
L = Stroke in feet
A = Piston area in sq. in.
N = Strokes per minute.

Substituting, we have:

$$\frac{57.2 \times 4 \times (22^2 \times 0.7854) \times 70 \times 2}{33{,}000} = 368.8 \text{ hp.}$$

Questions About the Greene Engine

WHAT is the normal speed of the governor?

2. What is the correct adjustment of the govenor rod?

3. Why is the round section of the head-end tappet longer than the one on crank-end?

4. What is the best regulation to be expected with a sudden change of load of from half to full load and what would you do to get the best regulation?

5. What is meant by the improved Greene Engine?

6. Why do some engines have a long, round projection under gage plate and some not have any projection?

7. What is the best liquid to use in the gag-pot?

8. I know of an engineer who runs his gage plate about 1/32-in. slack to get better regulation but my opinion is that it is wrong, what is your opinion?

Subscriber.

A. 1. The governor runs at about 200 revolutions of the flying balls, several different speeds having been used at various times. The governor pulley makes half that speed.

2. The governor rod is adjusted so that the tappets in the sliding bar are down on the bottom when the governor is at its highest point of travel.

3. This question is not clear.

Referring to the accompanying diagram the toe "K" at crank end of cylinder is made longest in order to make it hold on longer and thus equalize the cut-off and make up for the angularity of the connecting rod.

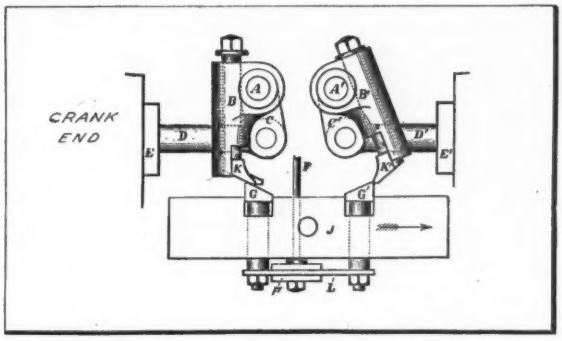


DIAGRAM SHOWING THE ACTION OF THE STEAM VALVE GEAR OF THE IMPROVED GREENE ENGINE

4. About 2 per cent. As to what to do to get the best regulation is a matter to be considered for each individual case.

5. The term "Improved" Greene engine was adopted in 1881, when the design was brought up to that date. Girder frame was adopted together with gridiron exhaust valves working on removable seats arranged across the cylinder and driven by an oscillating side shaft. The improvements also included the lifting toes, platform gage plate, new governor and toggle stop motion. The improved Greene engine was designed by the late Henry J. Johnson, at that time the Constructing Engineer for the Providence Steam Engine Co.

6. The long round projection under gage plate in the older engines contained a spiral spring. This was omitted in the later engines as not being needed.

7. Some kind of mineral oil is generally used in the gag-pot or controlling vessel, as we call it. It varies from kerosene to cylinder oil or glycerine. Usually engine oil is best, getting what gag is required by a screw adjustment for controlling the opening in a hole through the plunger.

8. The gage plates are built to run with close fits, and so are all the other connections from the tappets to the governor. After these gage plates have been run a few years, they all have some slack, which does not seem to affect the gear materially. The pressure is practically all downward. Backlash is quite in evidence when the tappets and toes get dull and rounded, and as a general thing this is not preferable. In some special cases—where there is a friction somewhere in the joints, for instance—a good shaking up once or twice every revolution will make the governor steadier.

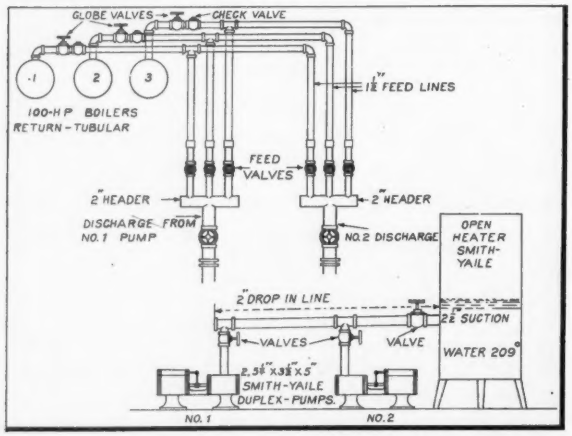
Problems for Discussion

What Would You Do Under These Conditions?

Feed Water Pump Problem

ACCOMPANYING diagram shows the arrangement of feed water piping and pumps in the plant where I am employed. The pumps have recently been repaired. The steam and water ends were rebored and new rings fitted; valve seats were planed and scraped to a fit. The valve gear was bushed and new pins made. New valves and springs were placed in water end and new rods and cast iron plungers made.

Both pumps are practically as good as new. Heater has been washed and is free from scale; check valve on boilers have been reseated and do not leak. The feed and suction lines are not obstructed in any way. The boilers are clean and in good condition. All this work has been done by first-class mechanics. No. 2 runs fairly good, but No. 1 pump will not pump against the boiler pressure of 100 lb. It will work fine pumping into an empty boiler, but as soon as I try it against a pressure it will slow down and hardly move with throttle wide open and exhausting into the atmosphere.



FEED WATER PIPING AND LOCATION OF PUMPS

The ports on the pump are ⅜ in. and I gave it 3/16 in. lost motion; do you think it too much or not enough? The crossheads are exactly in the center of the travel when the arms are plumb. The packing on the water end is not too tight and the suction and discharge valves have about ½ in. lift. The suction line is 2½ in. pipe, and has 2 in. drop from the heater. The feed water enters the top of the boilers and discharges along the top of the flues in the back. Feed water is about 209 deg.

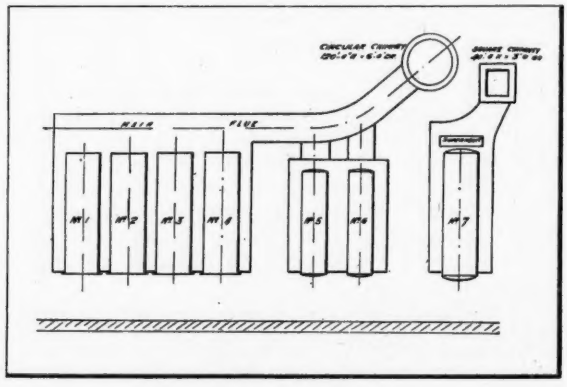
Now the question is, why won't No. 1 pump run as well as No. 2 when conditions are the same and everything, as far as I can see, is in good shape?

E. J. W.

Boiler Plant in a Coal Mine

A BATTERY of 7 boilers working in a coal mine are arranged as shown in the accompanying sketch. No. 7 is a "dish end" Lancashire boiler, 30 ft. long by 8 ft. 3 in. diameter, and can work at 120 lb. sq. in. if desired. It is isolated from the other boilers and connected to a brick chimney 40 ft. high by 3 ft. square at the top. The remaining boilers, which work at 80 lb. sq. in., are connected to a brick chimney 120 ft. high by 6 ft. diamter at the top.

At present No. 7 boiler is working at 80 lb. sq. in. and is coupled to the others through the main steam line. It is required that No. 7 should supply the set of high-speed generating engines developing a maximum of 200 hp., and I should like to know if this boiler can in any way be made adequate to do this work. It will be noticed from sketch that the 40-ft. chimney is not in a favorable position to give a good draught, owing to its close proximity to the higher chimney. Consequently, we found it necessary to put in the "Meldrum" steam pit blower to each furnace.



LAYOUT OF BOILER PLANT

I should like to ask here, if there is any danger of explosion in the furnace with this type of blower, and if so, how it may be prevented. Nos. 5 and 6 are 2 Babcock boilers of the single-drum type, each measuring 23 ft. 7 in. long by 4 ft. diameter, and an also work at 120 lb. per sq. in. if required.

It was found necessary to shut down No. 7, then Nos. 5 and 6 could be coupled to the engines, and would probably be quite able to do the work. Further Nos. 6 and 7 boilers could work together if necessary but the objection to using No. 5 or No. 6 boiler continually is, that there would be an insufficient supply of steam connected with the mine. The fuel burned in all boilers is the recovered smudge from the washing plant and may be taken at a calorific value of 6000 B.t.u.'s. The temperature of feed water entering boilers is about 180 deg. F. No. 7 boiler only has a superheater working in connection with it, which gives a super-heat of about 80 deg. F.

No. 7 boiler was placed in its isolated position particularly for experimental purposes and any information as to the best practical method of carrying out a test under these conditions will be much appreciated. H. J.

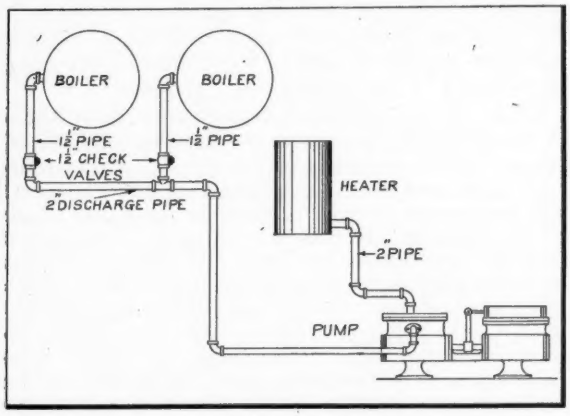
Wear in An Ammonia Compressor

CAN some reader of Practical Engineer give me a reason or reasons why ammonia compressors wear on the top surface of the cylinder instead of the bottom as one would naturally suppose? I have noticed in overhauling ammonia compressors both double and single acting horizontal types, whether running over or under, that the greatest wear is on the top of the cylinder. C. E. Anderson.

Pounding of Check Valves

ACCOMPANYING sketch shows the relative positions of our heater, pump and boilers.

The check valves pounds at every stroke of the pump. I would like to know what causes the pound,

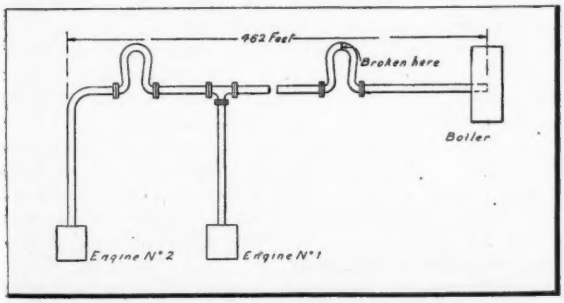


ARRANGEMENT OF PIPING AND LOCATION OF CHECKS WHICH POUND

and how to stop it. The pound is very severe, necessitating very slow pump speed. N. F. S.

Expansion Bends in Pipe Lines

A LINE of 2 in. steam pipe 462 ft. long irrespective of branches, was erected in a coal mine. In this length of pipe there are 2 horse-shoe expansion bends of 2 in. wrought iron steam pipe. A short time ago the pipes were allowed to cool, and the right-hand expansion bend in the course of contraction broke in the center of the crown, showing the iron to be



SKETCH SHOWING PIPING AND EXPANSION BENDS

crystalised. My opinion is that the fault lies entirely in the inferior quality of the tube from which the bend is made.

The opinion of the makers is that sufficient expansion bends have not been provided. I may say pipes are working at 100 lb. pressure, and this would raise temperature to about 340 deg. F. I estimate that 11 in. of expansion is taking place. The accompanying sketch shows the arrangement of piping. Can some reader give a more satisfactory explanation of the occurence?

Three-Wire Generator Trouble

REFERRING to the trouble of J. C. H. on a 3-wire generator which appeared in Feb. 1 issue of Practical Engineer, I would like to say that same kind of trouble came to my notice some time ago. The generators were the same type but 75 kw. capacity instead of 150 kw. A flash would appear now and then but

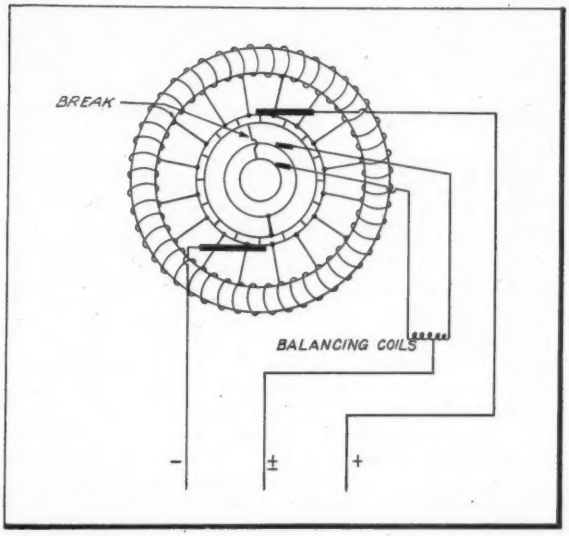


DIAGRAM SHOWING LOCATION OF TROUBLE IN A 3-WIRE GENERATOR

shifting brushes would have no effect whatever. After many weeks of laborious searching the trouble was at last found, and then only accidentally. One day when the machine was shut down, while cleaning and wiping it a break was found between one of the collector rings and the armature as shown in the accompanying sketch. Repairing the break ended all the troubles and there was no sparking afterward.

The humming as the writer says, may be due to mechanical construction. Joseph J. Pire.

IN the Feb. 1 number of Practical Engineer, J. C. H. speaks of having trouble with a 150 kw. 3-wire generator. He says the commutator is in good condition and is sandpapered frequently. If there are no high bars or flat spots, there should be no reason to sandpaper the commutator providing it is not burnt, but should be allowed to color and in time will show a good gloss.

Commutator should be lubricated with a good quality of oil. The oil should be put on a little at a time with a cloth. When shutting down the machine, take a small rag moistened with kerosene oil in one hand, and a dry rag in the other hand, and hold on the commutator so that the dirt that is loosened by the kerosene will be taken up on the dry rag. It would be a good idea to see that the brushes are spaced correctly around the commutator.

G. F. R.

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ELECTRIC MOTOR CONTROL

In the early stages of electric motor drive for industrial and power work, the controlling devices received little attention compared with other developments and were more or less cumbersome and inefficient.

When the advantages of electrically driven machinery became fully recognized, the field was naturally broadened, entailing more exacting operating conditions and necessitating a more flexible and convenient system of control. Further development in the art divided motors into classes with characteristics particularly adapted to the work to be performed.

The initial step in speed control was the introduction of the adjustable speed motor with the speed variations obtained by field weakening or varying the value of the applied electromotive force at the motor terminals or by the use of the combined method as exemplified by the multi-voltage system.

The earlier method of speed variation by the introduction of resistance in the armature circuit of a shunt- or compound-wound motor was open to serious objections as with a given resistance any variation in the load would increase or decrease the motor's speed. With regulation by field weakening and changing the impressed electromotive force, the motor gives practically a uniform speed at each notch of the controller.

Probably the widest individual application of motor drive is found in the operation of machine tools, especially that class having a purely rotary motion where a wide variation in speed is not only essential to economical production but absolutely necessary in the manipulation of metals of varying grades and hardness of texture.

Mechanical speed changing devices are no longer necessary as motors with suitable characteristics have been developed to give a wide range of speed variation and the modern controller is found in the most advantageous position for the machine operator. By means of this controller all speeds of the motor both forward and reverse are obtained by turning the controller handle.

Further development brought out the automatic control whereby the motor speed can be controlled from any one of several positions by the turning of a small switch or pushing a button. Automatic control has been successfully applied to many other lines of work such as controlling printing press, steel mill machinery, elevator and hoist motors.

Saving of time and labor by the use of automatic control is well exemplified in printing press work where the motor may be started, stopped and made to increase or decrease its speed by pressing one of several buttons in stations located on different parts of the press. These stations are provided with a safety button which when pressed locks all other stations so that it is impossible to start the press from some other point, endangering an operator who may be at work on some part of the press.

Automatic control finds a wide field in both alternating and direct current work and has become a distinct branch of electrical engineering, many large manufacturing establishments being devoted to its production as well as non-automatic controlling devices.

Elsewhere in this issue of Practical Engineer will be found the first installment of an article on the subject of motor control which describes the leading types.

TEST OF ENGINES IN A RAILWAY POWER PLANT

By C. B. Smith

A SHORT time ago we made a test of the 2 engines we have at our power station, to determine the steam consumption and efficiency at different loads.

There were 3 different tests made of each engine on successive nights, with conditions as nearly the same as it was possible to get them. We could not get much of an overload test on the larger engine, as our facilities for weighing the feed water were not adequate for that.

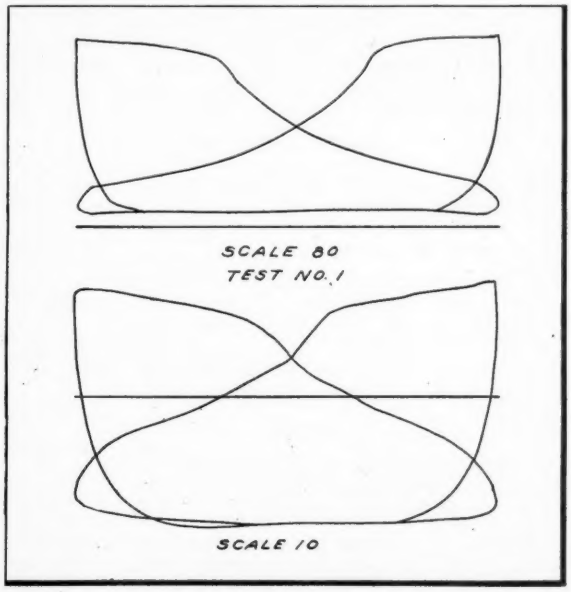


FIG. 1. SAMPLE OF CARDS TAKEN DURING TEST NO. 1

The steam consumption of engines was determined by weighing the water fed to the boilers supplying the engine. The quantity weighed was corrected for

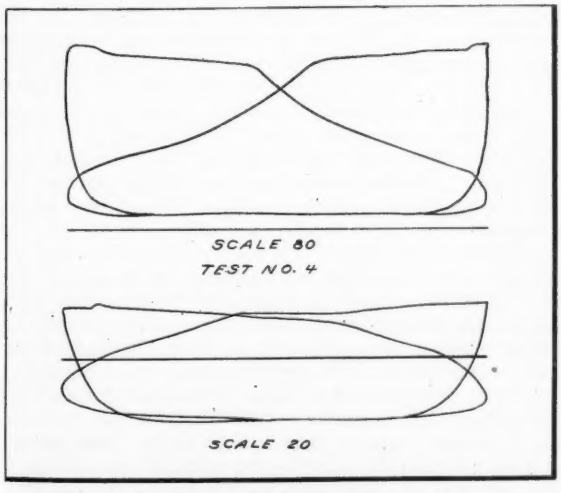


FIG. 2. CARDS TAKEN DURING TEST NO. 4

leakage from the blowoff valves of boilers, waste from calorimeter, and difference of water level in boilers at beginning and end of test.

Steam for condenser pumps and feed pump was taken from a different boiler.

Test No. 1 was of No. 1 engine, a cross compound Rice & Sargent engine of 800 rated hp., direct connected to a 500-kw. General Electric alternator. The engine exhausted into a Deane jet condenser with a double acting independent air pump 10 by 24 by 24 in.

Test No. 4 was of No. 2 engine, a cross compound Rice & Sargent engine of 1500 rated hp., direct connected to a 1000-kw. General Electric alternator. The engine exhausted into a Blake jet condenser with an independent double acting twin air pump 14 by 32 by 21 in. Both cylinders of each engine were steam jacketed on the heads only with steam at boiler pressure. Steam was supplied by Altman & Taylor water-tube boilers.

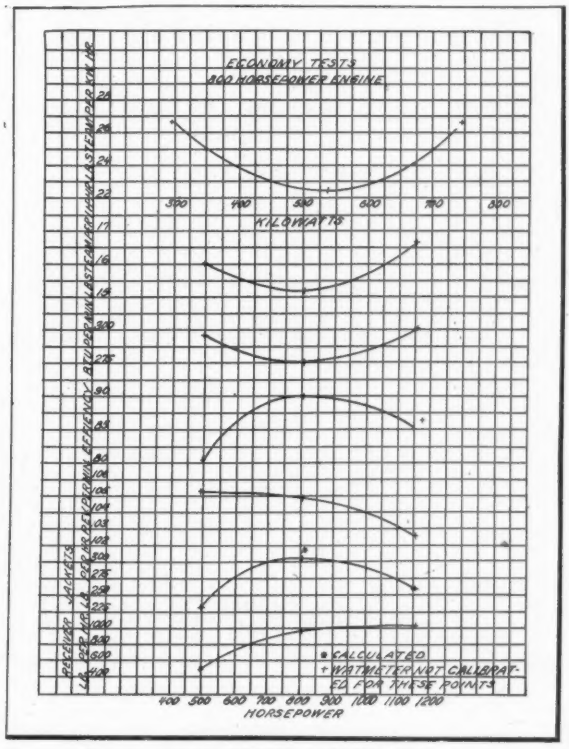


FIG. 3. TEST CURVES FOR ENGINE NO. 1

The engines had been in service 3 yr., running from 18 to 22 hr. a day and much of the time with a heavy over load.

One thing about it that seemed peculiar, was that the smaller engine showed less steam consumption per indicated horsepower hour at full load, going higher at heavier load as well as lighter load, while the larger engine gave less steam consumed per horsepower hour at the lightest load and gradually increased up to the full load test, as can be seen from the accompanying charts.

Dimensions of Engines

Cylinder Dimensions.	No. 1 H. P.	No. 1 L. P.	No. 2 H. P.	No. 2 L.P.
Bore .....in.	20	40	24	48
Stroke .....ft.	3½	3½	4	4
Diameter of piston rod..in.	3½	4 11/16	4½	5

Clearance in % of Piston Displacement .....%	4.01	6.74	4.14	6.81
Hp. constant for 1 lb. m.e.p. at 1 r.p.m.	.03281	.1324	.05387	.2182

Total Quantities and Corrections

Number of test	1	4
Per cent of full rating.....	100	106
Duration of test .....hr.	3.38	3.33
Total water fed to boiler.....lb.	41804	82823
Leakage from blowoff valves.....lb.	586	0
Waste from calorimeter.....lb.	442	186
Correction due to change of level...lb.	500	743
Net water used in cylinders of engine, lb.	40276	83380
Water fed to cylinder jackets.....lb.	1030	1070
Condensation from receiver .....lb.	3210	4860
Moisture in steam at throttle.....%	0.8	0.4

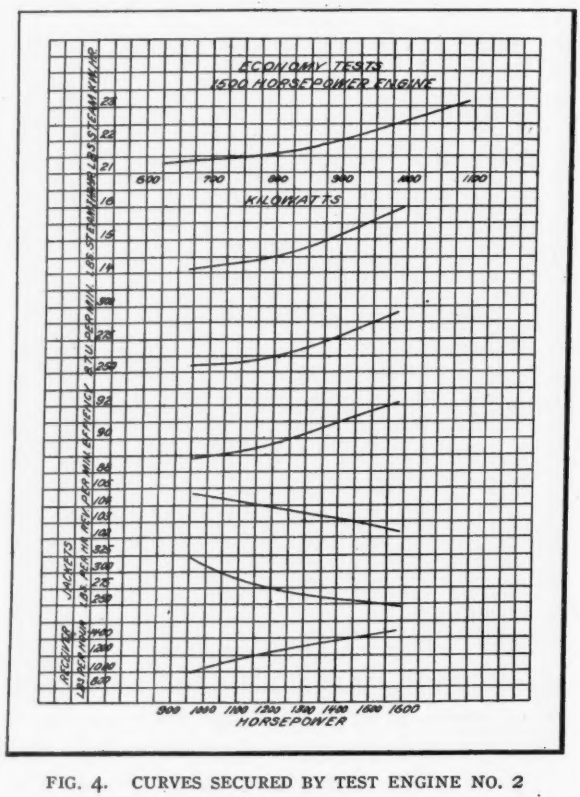


FIG. 4. CURVES SECURED BY TEST ENGINE NO. 2

Hourly Quantities

Total steam consumed by engine per hr. including jackets .....lb.	12215	25322
Steam consumed per hr. in cylinders..lb.	11910	25000
Steam consumed per hr. in jackets....lb.	305	322

Pressures and Temperatures

Steam pressure (gage) at throttle..... .....lb. per. sq. in.	141	139
Barometric pressure .....in. Hg.	28.8	29.6
Barometric pressure .....lb. per. sq. in.	14.1	14.5
Pressure in receiver (gage)..... .....lb. per sq. in.	9.0	9.4
Vacuum in condenser.....in. Hg.	25.3	25.6
Corresponding absolute pressure .... lb. per sq. in.	1.7	1.9

Speed

Revolutions per minute.....	104.8	102.3
Piston speed .....ft. per min.	734	818

Indicator Diagrams

Average cutoff per cent of stroke:		
High	33	51
Low	49	.67
M.e.p. lb. per sq. in.		
High pressure .....H. E.	67.36	82.19
High pressure .....C. E.	63.38	82.08
Low pressure .....H. E.	12.76	15.27
Low pressure .....C. E.	12.69	15.26
Indicated hp. developed by engine:		
High pressure .....H. E.	235	461
High pressure .....C. E.	215	444
Total	450	905
Low pressure .....H. E.	178	343
Low pressure .....C. E.	175	339
Total	353	682
Total i. hp. both cylinders.....	803	1587
Output of generator.....kw.	540	1091
Output of generator .....e. hp.	724	1460
Difference between i. hp. and e. hp.....	79	127

Efficiency Results

B.t.u. per i. hp. per minute, including heat used in jackets	276	291
B.t.u. per i. hp. per minute, neglecting heat used in jackets.....	271	288
Steam per i. hp. per hour, including steam used in jackets.....lb.	15.20	15.96
Steam per i. hp. per hour, neglecting steam used in jackets.....lb.	14.83	15.76
Steam per kw.-hr., including jackets..lb.	22.6	23.2
Mechanical efficiency of engine and generator .....%	90.1	92.2
Thermal efficiency of engine .....%	15.4	14.7
Thermal efficiency of engine compared with efficiency of non-condensing engine (complete expansion).....%	57.3	55.7

Indicator cards were taken every 10 minutes, steam and vacuum gages and wattmeters were read every 10 minutes and wattmeters were calibrated to be sure they were as nearly correct as possible.

The accompanying cards were taken at the time of test, since these were taken we have taken considerable of the compression off of the low-pressure side of each engine.

ARCHIBALD G. MONKS, of Boston, states that the all wood coal pocket, while cheaper to construct, is subjected to rapid depreciation and offers great fire risk as well as requiring many and costly repairs. Combination concrete and wood pockets have many of the good qualities of the all concrete pocket and can be erected at much lower cost. Such construction has reinforced concrete columns and floors with wooden walls, thus giving strength where it is needed and where depreciation is most likely to be rapid. Cheaper construction than for the all concrete is obtained because the wooden forms used in making concrete floors and supports are afterwards used in constructing the walls and partitions, thus saving material as well as not requiring so many forms to be constructed. It is less expensive than light concrete wall construction; in many cases concrete walls for pockets cost approximately from $1.50 to $2 more per ton of pocket capacity than timber walls. The interest alone over a period of 15 years on the extra cost of all concrete will pay for replacing entire wooden walls of the combination type.

The all concrete has many advantages, but taking everything into consideration, the combination type gives the largest returns for money invested.

PITTING OF BOILERS

Effect Produced in a Boiler When the Water is Too Pure

ONE correspondent has sprung the following question: "I have charge of a vacuum heating and electric plant where 2 new 16 ft. by 60 in. tubular boilers and one 14 ft. by 54 in. boiler are in use. The larger boilers have been installed a year and the smaller one for 6 years, and when cleaning one of the new ones I found that pitting had developed in the form of small rust colored blisters scattered over the bottom plate and above the flues of the rear head. The metal is being attacked under these blisters.

"Feed water enters the boiler through the blowoff and the water used is mostly returned from the heating system with very little new water added.

"I am using a little common soda to keep out scale and whenever signs of oil appear in the boiler I use caustic soda. There is a little scale in the boilers where the feed water enters, but the rest of the boiler is almost free from scale. The water is pumped from Lake Michigan and I would like to find what is the cause of the trouble."

This problem seems evidently to be a case of a water, which, by distillation and circulation through the heating system, has become so pure that it had to take up mineral matter and was therefore taking it from the boiler, lacking any other source. It was deemed best, however, to refer to an expert in such matters, and the following reply was received from W. A. Converse, Chemical Expert on feed waters and their treatment.

"First of all, you will recall that this is a heating system and that the greater portion of the feed water used in the boiler referred to is made up from time to time of condensed water or return water, there probably being an extremely small amount of fresh water used or added to the system from time to time, to take care of small loss due to leakage, evaporation, etc. This being the case, we would not expect any appreciable trouble in the way of scale-formation, but would at once know that they would certainly have trouble in the form of corrosion and pitting, as this trouble is always present in boilers using as a feed supply a large proportion of condensed water.

"It is also noticeable to a less or greater extent in the pipe and radiator system of all circulating hot water or steam heating plants. The trouble is attributable to the high purity of the condensed water which gives it a greater solvent action than it otherwise would have, or than it would have, if it carried a larger quantity of salts in solution, which would satisfy the solvent action. Understand that water is the greatest solvent known; in fact, it has a decided solvent action upon many of the metals, even on gold, and it is especially noticeable on the metal constituting the boilers and pipe system under consideration. It is only necessary to satisfy the water used in the boilers with such reagents as will satisfy its solvent action, and at the same time, not create any condition which would lead to other troubles such as scale-formation, etc.

"So far as the effect of the use of common soda is concerned, in keeping down the scale, this might have some beneficial effect when used for this purpose, but while doing this, it intensifies the corrosive action of the water as shown upon boilers in other localities. The same is true with the use of caustic soda for the removal of oil. It would be far better to provide for the elimination of the oil from the feed water so far as possible, thereby preventing it from entering the boilers themselves, than to try to remove it or take care of it in the boiler, especially if present in more than a trace or very small quantities.

"If you are in a position to investigate the conditions existing in plants of this type where condensed or return water constitutes a large portion of the boiler feed supply, you would find that, in all cases, trouble in the form of corrosion and pitting is taking place to a less or greater extent, and is attributable to no other cause than cited above."

CUTTING THREADS ON PIPE

Difference in Action Between Solid, Full Width Pipe Dies and the Narrow, Receding Die

IN discussing the cutting of thread on steel pipe, the Toledo Pipe Threading Machine Co. calls attention to its own practice as distinguished from that with the old style stationary die in which the width of the chaser has to equal the length of the thread in order to secure the necessary taper. The action of the above mentioned dies is so radically different from

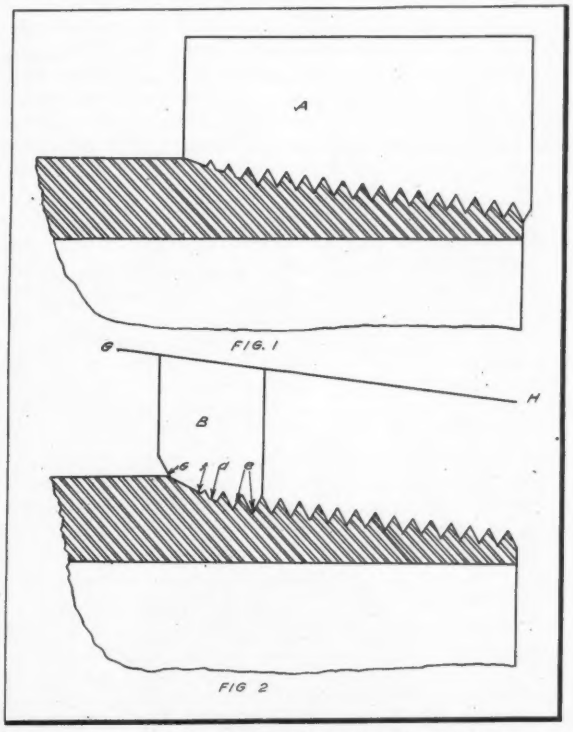


FIG. I. OLD STYLE CHASER IN CONTACT WITH COMPLETED THREAD

FIG. 2. NARROW DIE AND THREAD IT HAS CUT

the new narrow receding die principle that a few words of explanation may be in order.

They contend that the methods and data given in December Practical Engineer, p. 856, if applied under ordinary conditions in the average shop where the pipe is threaded, would not be productive of the best results possible to obtain, nor of the best economy of labor, and continue as follows: "In the illustrations, Fig. 1 represents a single chaser of the old type in contact with a finished thread; Fig. 2 a chaser of the narrow receding type as used in the Toledo tools.

"It will be clear that in using dies of the former type, each individual tooth of the chaser A will be cutting on both sides at once. And it also follows that all the teeth in the entire set of dies are engaged simultaneously. Approximately 144 teeth would be engaged at the completion of a thread on pipe from 4 to 7-in., for example, according to the table relative to the number of chasers given in the December article.

"The objections to this form of threading dies are many: The unnecessary amount of power required to cut a thread; the tendency of threads to tear off especially when threading steel; and the tendency to split the smaller sizes of butt welded pipe at the weld are perhaps the 3 most serious.

"The first of these is not so noticeable perhaps in power threading machines as with tools operated by hand. With the old style stocks and dies the combined efforts of 2 men are often required to thread a 2-in. pipe, while with dies made on the receding principle one man can cut a 2-in thread, or an 8-in thread, with one hand. This fact clearly demonstrates the relative amounts of power required.

"The difficulty in threading pipe without tearing the threads is due largely to the peculiar qualities of steel used in the manufacture of pipe. This difficulty seems to be accentuated when open hearth steel is used. This material, while excellent for the purpose intended, is not popular with the trade for the reason that it cannot be threaded readily with the wide form of dies. In fact, it is absolutely impossible to thread open hearth steel pipe with this type of dies unless they are made just right as to clearance, etc., are given a large amount of hook or rake and are kept absolutely sharp.

"It is a fact well known by any who are familiar with cutting tools of any description that a thin chip or shaving cannot be produced with a dull tool. In the case of the wide die, there is so little metal for each chaser to cut that unless it is very sharp it will ride over the thread until the increasing diameter causes it to dig in. When this happens any individual thread, being seized on both sides at once, will be likely to be torn out entirely. To make this clearer, we will assume that we are threading a 10-in. pipe with an old style die head having 12 chasers. Standard pipe has ¾-in. taper per foot, or 1/16 in. per inch. The increased diameter in ⅛ in., or one thread, would, therefore, be ⅛ of 1/16 or 1/128 in.

"Consider a chaser like A, 12 of these chasers making up the set of dies, and all working on the pipe at once: We will say No. 2 travels in the threads cut by the preceding chaser, No. 1, to a point formerly occupied by No. 1. In this 1/12 turn, the increase in diameter and the depth of cut would be 1/12 of 1/128 or 1/1536 in. or about ⅓ of the thickness of a hair. It is obvious that this small amount can only be cut with a very sharp tool. The result is usually, as stated before, the chaser will alternately slide over and dig in, thereby causing rough work, unnecessary friction and power consumption.

"Another circumstance that causes tearing is the tendency of the chips to clog or jam. This is due mainly to chips coming from the opposite sides of any given tooth meeting in the center of that tooth and jamming between the threads.. This action not only causes a very rough thread, but will often tear a thread out bodily. Various schemes have been tried to eliminate this trouble. Cutting out alternate teeth in the chaser gives some relief, but dies of this character are short lived.

"About the only way to make dies of this character practical seems to be as shown in Fig. 1 of the article referred to. And even this practice is not always effective in the case of dies made for threading several sizes of pipe because the excessive rake coupled with the necessarily excessive clearance will cause the dies to dig in and produce a wavy thread if it does not altogether stall the tool. It would appear that the main advantage gained by this construction would be to cause the chip to leave the thread at right angles to the surface of the pipe thereby clearing itself, instead of at right angles to the side of the thread where it would come in contact with a chip from the opposite direction and jam or clog as described in the preceding paragraph.

"Splitting pipe while threading, is caused by dull dies, and this process of alternately sliding over and then digging in, before described. If, when the thread is nearly completed, one of the chasers should happen to dig in at the weld, the wide cutting edge will usually split the pipe unless the weld is nearly perfect.

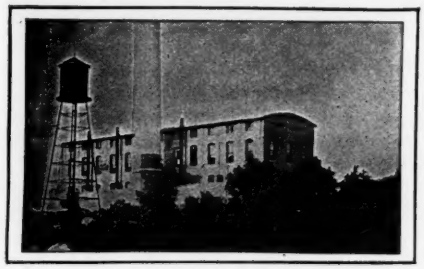
"The cutting action of dies made like B, and as used in Toledo devices, where the chasers are allowed to recede along the line GH, is entirely different from the dies made like A. The portion of the cutting edge at G acts in the same manner as a lathe turning tool and removes all stock not required for the thread. The part f cuts a shallow groove. The tooth d deepens this groove, while the full teeth e merely sharpen the the bottom of the thread. All chips leave the cut at approximately right angles to the pipe and there is no tendency whatever to jam and tear the thread. Open hearth steel pipe can be threaded as easily as iron, in fact, it is sometimes preferable to iron on account of its freedom from dirt. The cutting edge B being so narrow compared with A gives no danger of splitting pipe."

DESIGNING OIL ENGINE CRANK SHAFTS

IN a recent discussion regarding the design of oil engines, Wolcott Remington, who has had 10 years' experience in this work and has brought out the Blanchard Oil Engine, remarked that in designing the crank shaft of an oil engine there is no formula to be followed exactly, every one that is used being changed according to the judgment of the designer, this being necessary because of the various methods that might be used in the bearings.

Where a very hard metal is to be put in the bearings a smaller diameter of crank shaft of steel of high tensile strength could be used than if a soft babbitt metal was specified for the bearings. For a 10 by 10-in. oil engine using a maximum pressure of 300 lb., if ordinary 20-carbon steel is used for the crank shaft the diameter of the journals should be about 3½ in. and length 7 in.

This would give ample strength to the shaft and bearing surface and a soft babbitt metal could be used in the bearings. It is Mr. Remington's policy to design the bearings large and use a soft metal in the bearings rather than a smaller shaft with a hard metal in the bearings, the advantage being that if the journal runs hard the soft babbitt metal tears out without doing any damage to the shaft, whereas in the other case the shaft suffers fully as much as the bearing, if not more, and makes a very expensive repair job. Some idea of the saving this babbitt metal might make in a 4-cylinder 10 by 10-in. oil engine of the Blanchard 2-cycle type, will be appreciated when it is realized that the shaft for such an engine would cost more than $300.



Power Apparatus

In Shop and Market

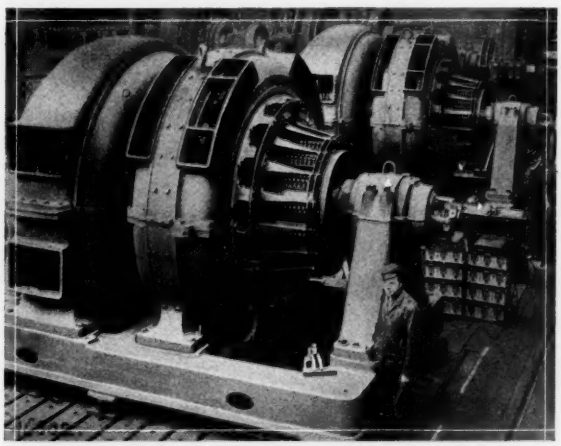
New Ideas in Making, Buying and Selling

LARGE MACHINES UNDER CONSTRUCTION

EXAMPLE of the activity of the Westinghouse Shops in building large machines is given in the view herewith, which was taken in one of the main aisles in the East Pittsburgh Works, showing some unusually large and interesting machines being built by this company. In the foreground are seen 2 motor-generator sets of particular interest. These sets are each of 1500 kw. capacity, consisting of 2250 horsepower, 12000 volt, 3 phase, 60 cycle synchronous motor direct connected to and mounted on a common iron base with a 1500 kw. 250 volt direct current generator.

These sets are for installation in a sub-station of the Cosmopolitan Construction Company, located in the basement of a department store in Chicago.

The openings shown in the frame are for the attachment of conduits which will conduct the heat from the machines to the outside of the building. This scheme of enclosure and ducts also serves to conduct the noise away from the building.



LARGE MOTOR-GENERATOR SETS UNDER CONSTRUCTION

To the left and rear of the synchronous motor-generator sets a 4000 kilowatt rotary converter, recently shipped to the Interboro Rapid Transit Company of New York, which is capable of handling a maximum swing of 8000 kilowatts. This machine is equipped with commutating poles, and is the largest rotary converter ever built. It will be of particular service in furnishing excess energy called for by the acceleration of the 10-car subway express trains.

To the right and rear of the motor generator sets are shown some 3000 kilowatt rotary converters built for the Chicago City Railway Company and the Philadelphia Rapid Transit Company. These machines clearly indicate the tendency of the operating companies toward the larger units.

In the immediate vicinity, but obscured from the view by the other machines in this aisle, are 2 12,500 kva., 6600 volt, 50 cycle, 300 r.p.m., vertical water-wheel generators, being built for the Rio de Janeiro (Brazil), Tramway, Light & Power Company, which are among the largest machines of this kind that have ever been built, and it is interesting to note that such machines are going to a foreign country, thus indicating the progress of Brazil along electrical lines.

NEW ELECTRIC FORGE BLOWER

ADVANTAGES of the electric forge blower over the hand blower or bellows may be stated as follows: It saves space as it is so small it can be put under the forge or any other place out of the way. It is started and stopped by a switch, which latter can be located wherever it will be handy to reach

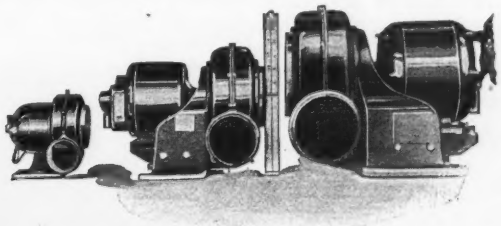


FIG. I. THREE SIZES OF FORGE BLOWER FOR LAMP SOCKET ATTACHMENT

from the forge or anvil. The blast produced is strong and positive. The fire builds up quicker and better than with a bellows or hand blower. More can be done

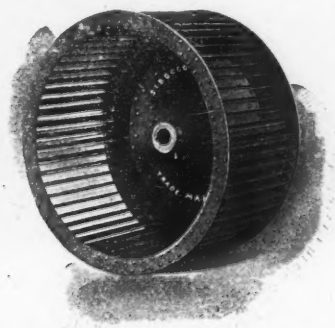


FIG. 2. SIROCCO FAN WHEEL

in the same time, as it requires no attention; while the iron is heating, other work can be prepared or finished.

The latest development in electric forge blowers is an adaptation of the Sirocco blower to that service. The 3 sizes shown in the illustration, Fig. 1, are 6½,

9½and 12½ in. respectively, the largest being capable of caring for 5 fires.

Because of the high mechanical efficiency of the new Sirocco turbine type wheel, Fig. 2, the electric current consumption is so small as to be almost insignificant. The smaller size, suitable for single light fire, uses less than half the current consumed by an ordinary electric lamp. The larger sizes are relatively of equal efficiency, all blower wheels are set screwed to the motor shaft, there being only 2 bearings on the entire machine.

A few of the many advantages of Sirocco electric forge blowers are: High mechanical efficiency, hence small current consumption; quiet running; large volume of air at ample pressure to overcome resistance of tuyere and fire; quick and hot fires because of perfect combustion of fuel in fire bed; smooth operation due to small diameter of runner.

These blowers are manufactured by the American Blower Company of Detroit, Michigan.

NEW BUILDINGS OF THE GOULDS MFG. CO.

THE Goulds Manufacturing Company has just completed a group of 4 new buildings. These buildings are located at the southwest corner of their No. 2 plant at Seneca Falls, and are known as Nos. 10, 11, 12 and 13.

This group of buildings will be used exclusively by the hand pump departments, and provide a material increase in the manufacturing facilities for this important branch of the company's business. As an example of up-to-date factory construction, they have several features of general interest.

The 3-story building shown at the lower left hand side of the bird's eye view is No. 10, which will be used as a warehouse. It is constructed of reinforced concrete, and is 60 by 240 ft. While at present it has 3 stories, the foundation and superstructure are built for an additional fourth story. A reinforced concrete loading platform runs along the south side of the building. This platform is protected by a canopy, also made of concrete. Six cars can be accommodated along the platform at one time.

The floors are of the beam and girder type. U. S. Steel sash and ¼-in. wire glass windows are used throughout. There are 2 electric elevators in towers adjoining the building, each having a capacity of 6000 lb.

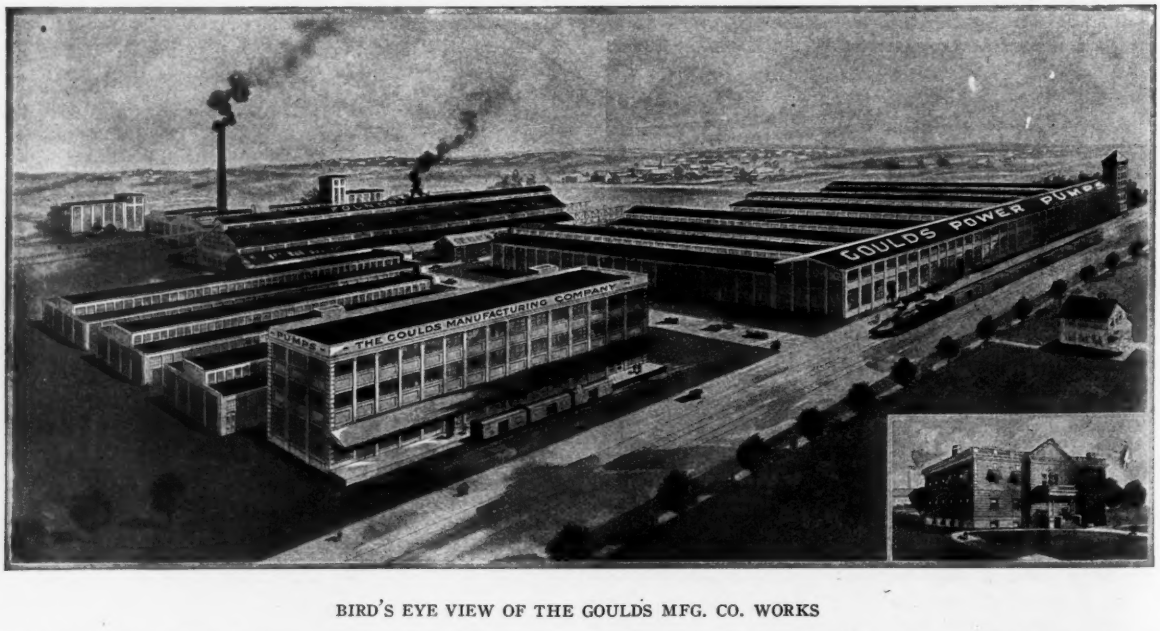
Numbers 11 and 12 are identical in general design, and are to be used as machine shops. They are constructed of steel and brick, and are each 100 by 300 ft. one story high. As no part of the hand pumps is heavy enough to warrant the use of cranes, the overhead steel frame work was designed so as to provide a rigid and convenient means of attaching the main line and counter shaft.

The roof of these 2 buildings pitches toward the center of the building, making all trusses alike, and providing maximum head room above the transmission lines. The windows are of U. S. Steel sash with ¼-in. wire glass. They extend from the bottom of the roof trusses to within 4 ft. of the floor, and run around the entire building without a break.

Building No. 13, located near the foundry, is for rough casting storage and is of mill type construction.

Exhaust steam from the power plant is utilized for heating, and a Goulds Figure 824½ Challenge vacuum pump is used on the vacuum end of the system. Building No. 10 is heated by direct radiation and the returns from this system, as well as those from Nos. 11 and 12 are handled by Warren Webster Motor Valves.

The heating plant for buildings Nos. 11 and 12 is housed in a separate building. It consists of a 200-



BIRD'S EYE VIEW OF THE GOULDS MFG. CO. WORKS

in. Sturtevant steel plate fan, with a capacity of 60,000 ft. of air per minute and a heater containing 12,000 lineal ft. of 1-in. pipe. The heated air is distributed in the buildings through underground ducts.

The buildings are lighted by 250-watt, General-Electric tungsten lamps, spaced 16 by 25 ft.

With the addition of these new buildings the output has been greatly increased and the company feels that it will now be able to handle its large and rapidly

growing business, in a way that will enable it to make prompt deliveries on all orders.

The buildings were designed by the Engineering Department of The Goulds Manufacturing Company, under the direction of Messrs. A. L. McHugh, works engineer, and H. H. Hall, supervising architect.

NEW PLANT FOR MANUFACTURE OF GASKETS

How Specialization in a Particular Product Has Developed a Large Business

WHAT specialization in a manufacturing business accomplishes in the way of rapid development is well exemplified in the new plant of the Victor Manufacturing and Gasket Company in Chicago. This company started but a few years ago to manuafcture gaskets in sizes ranging from a half inch to 5 ft. in diameter, for all purposes, and has confined its efforts to this product alone.

When arriving at the plant the visitor is confronted by a new 3-story building, 125 by 50 ft. Upon entering, one is at once impressed by the light and airy appearance and the manner in which the work is

THREE TYPES OF VICTOR GASKETS

handled for logical sequence of operation. The ground floor is devoted to the stock department, where thousands of finished gaskets are ready for immediate shipment. These are arranged in row after row of drawers, graded according to size and style. There also large quantities of finished parts ready for assembling and the systematic arrangement would make the up-to-date housewife envious, and she might well learn a lesson in the arrangement of her small stores at home.

On the second floor the real center of interest is found, where the actual manufacturing process is carried out. In this department 1200 to 1500 lb. of copper and 900 lb. of brass are reduced to small parts by a long row of punching presses and as one sees the great rolls of sheet metal disappear as if by magic he is put in mind of a lot of mighty animals greedily devouring their food. On this floor there is a fully equipped tool room for the manufacture of the dies used in cutting the metal, which, when not in use, are stored in a spacious fire-proof vault.

One exceedingly interesting feature is the small amount of waste material left after the stamping process. The centers left from the blank for each size of gasket from 2 ft. in diameter downward are utilized over and over again, and in reality if placed one inside the other, would form a series of concentric rings.

Asbestos, copper and lead must not be forgotten as one of these materials forms the center of each gasket, enclosed in its armor of copper or brass. These materials, too, have to pass through the presses where they are cut into rings, the centers of which are used for smaller rings, as with the metal.

The punches, with one operation, cut the ring of metal and flange the inner edge. The filling ring of lead, asbestos or rubber is slipped over the flange, which is then pressed down by a special process.

In the French type of gasket the outer edge or periphery is open, the metal forming the side surfaces. In other types the metal is formed into what may be called pipe shape, producing a hoop of metal with the seam on one side. In large sizes these gaskets are not round, but have a rectangular cross section.

It is interesting to note that with the improved method and machinery employed, that a boy can assemble and finish 11,000 half-inch gaskets in a day.

After finishing the inspection of the manufacturing process we ascended to the third floor, which is occupied by the general and private offices, to say goodbye, and on leaving the thought paramount in our minds was that when the energies of a company are bent on the production of one specialty, the quality of the product and the quantity produced can be raised to the highest possible standard.

FRANCIS H. STILLMAN

FRANCIS H. STILLMAN, president of The Watson-Stillman Company, and a prominent figure in machine tool and engineering industries, died suddenly Sunday morning, February 18th, of intestinal hemorrhage, at his late residence, 105 Rodney Street, Brooklyn, in his sixty-second year. The day before his death, he was at his office as usual and apparently in the best of health.

Mr. Stillman was born in New York on February 20, 1850, was graduated from Yale in the class of 1874 with the degree of B. S. He is survived by his widow, formerly Miss Irene A. Bancroft of Boston, and by 2 sons, Austin Frank and Edwin Arthur Stillman.

Mr. Stillman was a member of the Hanover Club of Brooklyn, the Engineers Club, the American Society of Mechanical Engineers, treasurer of the National Association of Manufacturers, and a director of this association since its organization. He organized and was first president of the Machinery Club of New York, and was also first president of the National Metal Trades Association. In addition to being president of The Watson-Stillman Company at the time of his death, he was also president of the Bridgeport Motor Company and of the Pequannock Commercial Company, and a director in other manufacturing firms.

Aside from his continuous activities in various engineering organizations and projects, Mr. Stillman was one of the pioneers in hydraulic machine tool construction. On leaving college, Mr. Stillman first associated himself with the Cottrell Printing Press Co., then with his stepfather, Mr. Lyons. In 1883 he organized and became president of the firm of Watson & Stillman which succeeded Lyons & Co. The firm was incorporated in 1904 as The Watson-Stillman Company, Mr. Stillman remaining its president up to

the time of his death. Under Mr. Stillman's direction, his firm early became prominent in the hydraulic engineering field, has built upwards of 4000 different types and sizes of hydraulic machines and has now a large and active plant in Aldene, N. J.

Mr. Stillman's affable disposition, high standard of business integrity and kind personal interest in all those with whom he came into contact, won for him a large circle of friends that will keenly regret their loss in his death.

NEWS NOTES

THE BEST MFG. CO., of Pittsburgh, has secured the services of Howard W. Evans as general manager of sales, and he will in future supervise the sales, order and engineering departments. Mr. Evans was formerly connected with the Crane Co., of Chicago, in a position similar to that which he now holds with the Best Mfg. Co.

THE EXTENSION of the shop of The Terry Steam Turbine Co., at Hartford, Conn., is now completed, and the equipment has been installed. With the former plant 1000 Terry Steam Turbines have been built on order and are in operation, but with the additional space the output can now be increased 100 per cent. The Terry Steam Turbine Company announce that orders on hand are larger than ever before in the history of the company.

THE NEW AMERICAN IDEA of the Safety Engineer, an accident prevention specialist, will be brought to the notice of world industrialists at an International Safety Congress, to be held in Milan, Italy, for 5 days, beginning May 27, 1912.

This Congress, the first of its kind of international scope ever held, will be for the purpose of setting in motion a world wide movement for the conservation of human life in industry.

The American Museum of Safety, 29 West 39th St., New York, is making preparations so that the United States will be well represented. An American National Committee has been selected by the American Museum to co-operate with the International body and to promote the American ideas and views at the Congress.

The following are some of the papers which will be read at the Milan Congress:

"The Safety Engineer on a Large Transportation System," by Dr. W. H. Tolman, Chairman, American National Committee;

"How the New York Edison Safeguards the Lives and Limbs of Its Employees," by Arthur Williams;

"The Work of the Safety Committee of the United States Steel Corporation";

"Safeguarding the Traveling Public and Protecting the Employees of the Electric Street Railway Association";

"Proper Illumination and Accident Prevention," by J. V. Lansingh, President of the Illuminating Engineering Society.

ANNOUNCEMENT OF THE civil service examinations is made by the U. S. Civil Service Commission, Washington, D. C., the following being of interest to engineers: On March 13, Civil Engineer for the Philippine service, Civil Engineer Student, Junior Engineer at Large, Junior Mechanical Engineer for the Bureau of Mines, Junior Mining Engineer, Bureau of Mines, Local and Assistant Inspector of Boilers and Local and Assistant Inspector of Hulls.

For April 10, examinations will be held for Cadet Engineers for the Light House service, Civil Engineer for the Departmental Service, Civil Engineer and Draftsman, Mechanical Draftsman for the Isthmian Canal Service, Engineer for the Indian Service, Junior Civil Engineer at Large, Junior Mechanical or Electrical Engineer for the Department at Large. Application forms and full information in regard to examinations may be obtained by addressing the U. S. Civil Service Commission, Washington, D. C., or the secretary of the Board of Examiners at Post Office at Boston, Mass., Philadelphia, Pa., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Cal.; Custom House at New York, N. Y.; New Orleans, La.; or Old Custom House at St. Louis, Mo.

BENJAMIN S. REYNOLDS, who for some years has been a member of the engineering staff of the Chain Belt Co., in its Milwaukee office, has recently taken charge of an office which has been opened by that company at 900 Old Colony Bldg., Chicago. He will handle, at the Chicago office a complete line of elevating and conveying machinery.

CATALOG NOTES

FORM NO. 4016 from the Ingersol Rand Co., of 11 Broadway, New York City, describes the imperial valveless telescope-feedhammer drill, describes the details of construction and shows how to take care of the mechanism.

THE BOWSER OIL FILTRATION and Circulating Systems are adapted for any size or type of steam plant and the how of these systems with the details of the Bowser cylinders are clearly indicated in the latest catalog sent out by S. F. Bowser & Co., of Fort Wayne, Ind. The system is one which cleans the oil and the book is one which tells you how and why.

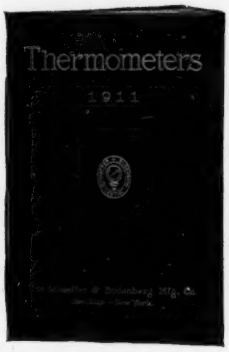
JEFFREY POWER TRANSMISSION MACHINERY, catalog No. 50, issued by The Jeffrey Manufacturing Co., of Columbus, Ohio, is really an encyclopedia on apparatus used for power transmission. Not only does it give tables for finding the horsepower or shafting for line transmission, dimensions of shafting, couplings, clutches, collar bearings and hangers, and other transmission devices, but it gives full details in regard to friction clutch couplings, and split iron and wood pulleys, used for rope and accessories for rope drives, wire and manila transmission rope and Jeffrey gears of all kinds and sizes. Interesting tables and diagrams are given in regard to the combined effect of bending and twisting moments on shafting and also in regard to the horsepower which belts will transmit. The book contains 140 pages of good power plant information.

N. T. C. BULLETIN No. 8, published by the National Tube Co., of Pittsburgh, describes National Coating, which is a system of protection against external corrosion and electrolysis. The bulletin describes the coating, tells the process of applying and summarizes the advantages of its use.

CONDENSITE IS a material used for plastic mouldings for such materials as electric insulation parts, valve disks, twist handles and bases and like objects. Its properties and some materials made from it are shown in a booklet recently received from the Condensite Co. of America, Glen Ridge, N Y.

THERMOMETERS, 1911 stands out in embossed gold letters from the front cover of the new catalog issued by the Schaeffer & Budenberg Mfg. Co., of New York City. These thermometers are made in various form, sizes and graduations up to 1000 deg. F. and

are mounted on a metal back which fits by means of a union into a thermometer cup. The mountings are made for straight, right-angle or oblique setting, as may be most convenient. The catalog also includes glass thermometers with engraved stems, Armored thermometers, barometers for measuring high tem-

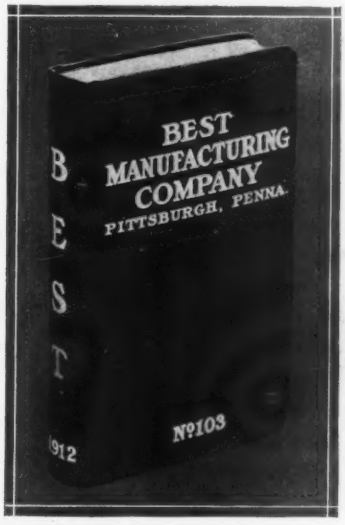


peratures, mercury expansion thermometers with reflexible connecting tube for mounting at a distance from the point where temperature is measured, and Columbia recording thermometers in various styles.

THOSE WHO LIKE fine catalog work will be especially pleased with the new book from the Burt Mfg. Co., of Akron, Ohio. This is devoted to the subjects of Oil Filters, Exhaust Heads and Ventilators, and shows not only the construction of these devices and how they operate, but tells also many interesting facts and expedients in regard to power plant management. It discusses, for instance, the cost of lubrication, the reduction in coal and repair bills from good lubrication, the saving to be accomplished by the use of filters, the proper installation of filters and of central oiling systems for plants. On the subject of ventilation it takes up the advantages in increased capacity of workmen from ample ventilation and how such ventilation may be easily and positively secured. Some striking facts are given in regard to ventilation in general and the Burt ventilators in particular, one of the most striking of these being an illustration in which a Burt ventilator is shown supporting a total weight of 1762 lb. The catalog is as handsome as it is interesting, both in its general make-up and illustrations, and in the very attractive embossed cover. Copies may be secured by writing to the Burt Mfg. Co., at Akron, Ohio, and mentioning Practical Engineer.

THE NAME, "Sketch Book," was made famous in literature by Washington Irving many years ago; in catalog literature it is likely to be made notable by a new publication from A. L. Ide & Sons, Springfield, Ill. This contains interesting sections and full views of all details of the important parts of the Ideal Engines built by that firm, and instructive and interesting notes accompanying each view. It is something distinctly different in advertising, both as to the attractiveness and clearness of the wood cut illustrations and the condensed statement of facts in regard to approved practice as to the construction of engine details. Copies may be had by writing to A. L. Ide & Sons, Springfield, Ill.

COPY OF THE 1912 complete catalog No. 103 is received from the Best Manufacturing Co., of Pittsburgh. This shows not only material of the company's own manufacture, but such additional material not manufactured by them as is usually included in power plant piping equipment. The catalog is use in a great measure as a reference book as well as a catalog. Contents are divided into 3 general classifications—Material, Miscellaneous and Dimensions. Material is divided into that suitable for standard, that is, for 125 lb. steam working pressure; for low pressure of 25 lb.; for medium, 175 lb.; extra heavy, 250 lb.; extra heavy hydraulic for 800 lb. water pressure; and special hydraulic for 1500 lb. water pressure. Miscellaneous items are those associated with power piping systems but not directly a part of the system. The dimensions are separated from the rest of the catalog because in laying out work the engineer or draftsman is interested in dimensions entirely and cares not about prices; on the other hand in buying, the purchaser wants prices and not dimensions, so that the prices are given under material, and dimensions are taken care of in a separate section. This dimension section also



includes a number of tables of data much used by engineers and arranged to be especially suitable for use in laying out and operating piping systems. The book contains 400 pages, is attractively arranged and well printed on a heavy paper and is contained in a substantial cloth binding so that it makes a convenient and useful volume for the engineer's desk.

FROM E. KEELER CO., of Williamsport, Pa., comes a pamphlet with an illuminated head and border, entitled "Lighten Your Machinery Loads with Albany Grease." This discusses the laws of lubrication, and shows what Albany Grease, in different grades, will do, and the kind of work for which each grade is adapted.

THE GENERAL ELECTRIC CO. has recently issued Bulletin No. 4918, which illustrates and describes panels designed by that Company for general use in central stations. The list of panels contains both generator and feeder types, and the panels are made for 125, 225 and 600 volts.

Bulletin No. 4887 is a rather attractive bulletin, illustrating and describing G. E. Turbo-Generator Sets in capacities of from 5 to 300 kw. All of these sets are of the horizontal type and can be arranged to operate either condensing or non-condensing, and at any steam pressure above 80 lb. for the smaller sizes and 100 lb. for the larger.

Bulletin No. 4900 is devoted to apparatus used in connection with Series Incandescent Street Lighting, and supersedes in part the company's previous bulletin on this subject. The bulletin is practically an ordering catalog and contains no description other than that afforded by the illustrations. It lists lamp brackets of various

styles (giving their dimensions), tungsten economy diffusers, G-E Edison Mazda street series lamps, constant current transformers, switchboard panels, and lightning arresters.

Bulletin No. 4924 describes the General Electric Company's Thompson Prepayment Watthour Meters for direct and alternating current. Types CP-4 and IP-4.

Small Plant Direct Current Switchboards is the title of Bulletin No. 4919. The bulletin is devoted to a description of panels which are designed for the control of 3-wire generators. The panels are arranged for 125 and 250 volts, and in capacities of from 25 to 100 kw.

Bulletin No. 4907 contains interesting data relative to the lighting of offices, banks and public buildings, by G. E. Edison Mazda Lamps. In this connection are shown illustrations of numerous buildings lighted with these lamps and data are included, giving the number and sizes of the lamps in each installation. The publication also contains a history of the development of the incandescent lamp, and other information of interest to the consumer of current for lighting purposes.

Bulletin No. 4917 illustrates and describes G. E. direct-current exciter panels which are for use in connection with alternating current generator panels, when for any reason separate control of exciters is desired. This supercedes the company's previous bulletin on the same subject.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—As Engineer. Five years' experience with engines and dynamos, a. c. d. c. No bad habits. Good references; 27 years old. Position in Wisconsin preferred. Address Box 205, Practical Engineer, Chicago, Ill.

POSITION WANTED—As chief engineer in Refrigerating or Ice Plant. Eight years experience with Boilers, Refrigerating Machines, D. C. Generators, Steam Heating, Erecting and Repairing. West preferred. Reference. Address 208, Care Practical Engineer. 3-1-1

POSITION WANTED—In the South, on account of my wife's health. Have 14 years experience with Electricity, Gas and Steam Engines, Air and Water. Eight years at present place. Best of references. First class license for Ohio. Address W. A. Jones, 2276 Auburn Ave., Toledo, Ohio. 3-1-1

WANTED—Position as Mine-Boss and Electrician at a small coal mine, where, owing to the limited number of machines and size of the mine, one man can look after both. Am employed at present in this capacity. Can satisfy interested parties as to my ability to produce the goods. Address Box 206, Care Practical Engineer. 3-1-1

POSITION WANTED—As engineer in small plant. Have had experience with direct current generators. No bad habits. Good references. 30 years old. Position in Illinois preferred. Address Box 203, Practical Engineer, Chicago, Ill. 2-15-1

POSITION WANTED—By engineer with first class Massachusetts license and training. Thoroughly experienced with Corliss, compound, condensing and other types of engines, St. Ry. power stations, electric stations, textile, paper and saw mills, factories and pumping stations. Slight experience with refrigeration. Desire steady position at once, day or night, country preferred. Address W. E. Chandler, Box 333, Northbridge, Mass. 3-1-1

Help Wanted

SALESMAN—HIGH GRADE, RESPONSIBLE man, who is practical and visits power plants regularly, may arrange to represent a line of boiler specialties that offer unusual opportunities. Good for at least $2500.00 additional income. Established Michigan house. State age, record, what now handling and exact territory covered. Address Box 207, Practical Engineer, Chicago, Ill. 3-1-1

SELLING AGENTS WANTED in important centers for Betson Plastic Fire Brick. See page 103 in this issue. Betson Plastic Fire Brick Company, Rome, New York. 12-tf

COMPETENT AND EXPERIENCED stoker erectors at once. State age, experience, reference and salary expected. Give full details. Address Box 168, Practical Engineer, Chicago, Ill. tf.

HELP WANTED—ENGINEER WANTED in every city and town to instruct our customers in indicator practice. If you have a fair working knowledge, we will "do the rest." Good pay to reliable, intelligent men. Write for particulars. Lippincott Co., Newark, N. J. tf.

ENGINEERS AND MECHANICS—To make big money selling incomparable "ZIZ" Hand Soap. A 10-cent can will instanly remove more dirt and stains from the hands than four cakes of any soap made, and will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. tf.

AGENTS WANTED TO HANDLE ESTABLISHED steam specialty which is known all over the country. Can be handled with non-conflicting specialties. Will give exclusive agency only for amount of territory actually covered by agent or his salesmen in the following states: Virginia, North Carolina, South Carolina, Oklahoma, Wyoming, Georgia, Arizona, New Mexico, Montana, Idaho, Florida, Arkansas, North Dakota, South Dakota. Address Post Office Box 1754, Pittsburgh, Pa. 9-tf.

Wanted

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf.

WANTED—5,000 STATIONARY ENGINEERS to send us their name and address. A good proposition open to each one. For full particulars, write Henry W. Lord, 7 S. Greene St., Baltimore, Md. tf.

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FOR SALE—INDICATOR, REDUCING WHEEL, planimeter, best make, in fine order. Examination allowed before payment. Price low, in fact a sacrifice. Address Mrs. N. L. Browning, East Orange, N. J. tf.

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INVENTORS SECURE PATENTS without attorney fees. Free particulars. Washington Specification Co., Washington, D. C. 3-1-1

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENTS—C. L. Parker, Attorney-at-law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request. 186 McGill building, Washington, D. C. tf.

Miscellaneous

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. 1-15-3

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. M. Y. C., 1413 W. Jackson Blvd., Chicago, Ill. tf.